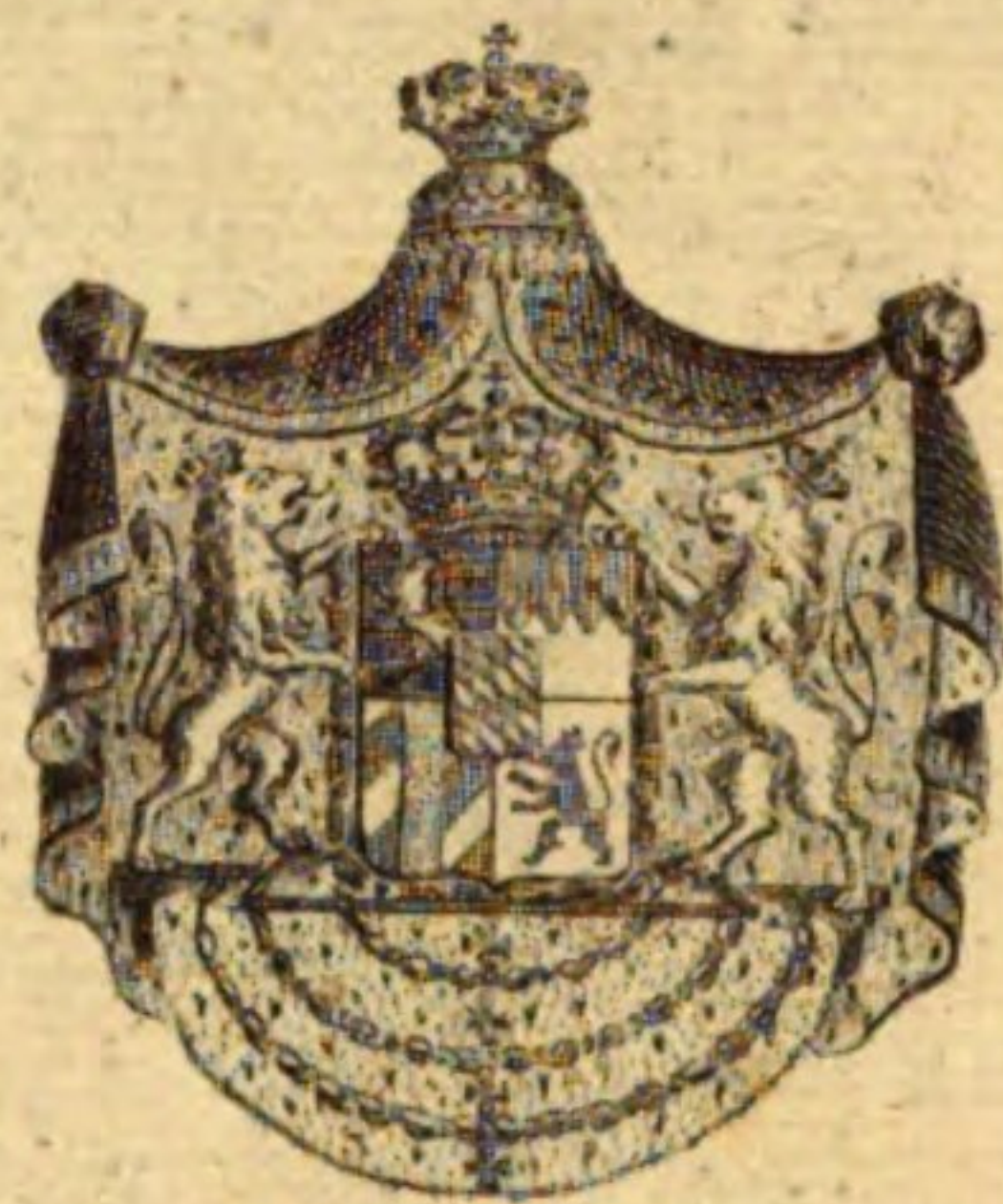


4 Litt. 84 ^m
(✓)



BIBLIOTHECA
REGIA
MONACENSIS.

5556 aben

Ex donat. Molliana.

<36635058170019

<36635058170019

Bayer. Staatsbibliothek

MINERALOGY
OF THE
SCOTTISH ISLES;
WITH
MINERALOGICAL OBSERVATIONS
MADE IN A *TOUR* THROUGH DIFFERENT PARTS OF
THE MAINLAND OF SCOTLAND,
AND
DISSERTATIONS
UPON
PEAT AND KELP.
IN TWO VOLUMES.

Illustrated with Maps and Plates.

BY
ROBERT JAMESON,
FELLOW OF THE ROYAL AND ANTIQUARIAN SOCIETIES OF EDINBURGH,
LINNÆAN SOCIETY OF LONDON, PHYSICAL SOCIETY
OF JENA IN SAXONY, &c.

*Observationes veras, quam ingeniosissimas fictiones sequi præstat; Naturæ
mysteria potius indagare quam divinare.*

BERG. De Form. Crystallor.

VOL. I.

EDINBURGH: PRINTED BY C. STEWART & CO.
FOR B. WHITE & SON, FLEET-STREET, LONDON; AND W. CREECH, EDINBURGH.

1800.

4 Lbs. 84 ^m (A)

THE NEW YORK PUBLIC LIBRARY

411 0 7 11

FEAT AND KELL

100

Bayerische
Staatsbibliothek
München

335

TO

JOHN WALKER, DD. MD.

FELLOW AND SECRETARY TO THE PHYSICAL CLASS
OF THE ROYAL SOCIETY,

REGIUS PROFESSOR OF NATURAL HISTORY,

AND

KEEPER OF THE MUSEUM OF THE UNIVERSITY
OF EDINBURGH;

THIS VOLUME,

OF THE

OUTLINE OF THE MINERALOGY OF THE SCOTTISH ISLES,

IS DEDICATED,

AS A TESTIMONY OF THE GREAT REGARD AND ESTEEM

OF HIS MUCH OBLIGED PUPIL,

AND OBEDIENT

HUMBLE SERVANT,

THE AUTHOR.

SHERIFF-BRAE, LEITH, }
20. JULY, 1800. }

TO

JOHN WALKER, DD. MD.

FELLOW AND SECRETARY TO THE PHYSICAL CLASS

OF THE ROYAL SOCIETY,

REGIUS PROFESSOR OF NATURAL HISTORY,

AND

KEEPER OF THE MUSEUM OF THE UNIVERSITY

OF EDINBURGH;

THIS VOLUME

OF THE

OUTLINE OF THE MINERALOGY OF THE SCOTTISH ISLES

IS DEDICATED,

AS A TESTIMONY OF THE GREAT REGARD AND ESTEEM

OF HIS MUCH OBLIGED PUPIL,

AND OBEDIENT

HUMBLE SERVANT,

THE AUTHOR.

PRINTED BY
20, JULY, 1800.

PREFACE.

I UNDERTOOK the journeys, of which I now presume to lay the notes before the public, in order to acquire, from actual observation, a knowledge of the mineralogy of the Scottish Isles.

I have chosen the form of a journal, because I wished to convey the information I had gleaned in the stile of detailed observation, and in that order which the appearance of the country naturally suggested. But, in adopting this form, I am anxious to caution the reader against expecting that entertainment, and kind of information, which form the groundwork of the many journals through the more interesting parts of our island. If any one shall find this Outline of the mineralogy of these countries deficient in incident, in episodes and stories, and in descriptions of picturesque and romantic

scenery; let him recollect, that to indulge in such descriptions was incompatible with the design of this work. I do not despise those ornaments; and I hope that I have not been insensible to the emotions which naturally arise from the retired and striking scenes which often burst upon me in the unfrequented tracts which my pursuits led me to explore: but I have thought it foreign to my purpose to obtrude these things upon the public.

Another resolution I had formed to myself, and which partly indeed led me to choose the form of a journal, was, to shun the fascinating evil of speculation and hypothesis, which mars all faithful observation. It would ill suit my talents to venture upon deep speculation, were I inclined; and perhaps the state of mineralogical knowledge forbids it. It is a fitter task for me to record faithfully what I have myself examined, and to give a fair report of the materials which were collected, than to expose myself, by the form or arrangement of the work, to the danger of having the facts twisted and perverted by hypothesis, the rage for which is as remarkable in this as in the other sciences.

While, in mineralogical pursuits, there is much to interest a philosophical mind, the object of true value is its application

to

to economical purposes. I fear that the theories of the formation of the earth, interesting as they are, often mislead the mind, and pervert the understanding; and those who yield to them, become so involved in delusive speculations, so blind to fact and experience, that, like Archimedes, they find but one thing wanting to raise worlds.

Of the utility of this science there can be no question; more particularly when it is freed from the vague suppositions of the theorist. It is a ground-work, without which the observations of the geologist, and the labours of the miner, will ever be uncertain, and of little utility. It is a science, the cultivation of which will raise a country to importance, by exciting new sources of industry, even in situations where the labours of the husbandman will be employed in vain. But, though I am well convinced that the importance of every thing in mineralogy is in proportion to its accuracy, I would not be understood to represent these notes as a complete account of the mineralogy of the countries of which they treat—I give them to the public as an imperfect outline. The mineralogical history of a country is to be accomplished only by studying at leisure all the varieties and disposition of the strata and veins, and the appearances of the mountains and valleys: an investigation which the utmost care, in a rapid survey, must leave in

many

b 2

many particulars imperfect, especially when the mineralogist is perplexed with the difficulties of travelling among unfrequented islands.

I have in this, as in a former work, separated the particular account of the strata and veins from that of the particular fossils; as the common method of conjoining them appears often to lead to confusion, and can never be sufficiently correct. In describing the fossils, the method and nomenclature of the best mineralogists has been followed. The chemical characters, which form even the foundation of many mineralogical systems, I have seldom employed; from a conviction that the chemical part of mineralogy, notwithstanding the late improvements in the art of analysis, is still to be considered as imperfect. We have only to observe the contradictory results obtained by the best chemists in decomposing the same fossil, to be convinced that the analysis of the present day, although much improved since the time of Bergman, is still of no very great utility in mineralogy.

The drawings of scenery, and the mineralogical plans, which accompany this work, were executed by the elegant pencil of my friend Mr. Charles Bell. In the views of scenery, he has happily expressed the different characters which the rocks assume from the effects of the weather; a circumstance which renders

renders them the more valuable. The mineralogical plans are of much consequence in elucidating several curious facts, which otherwise would with difficulty have been understood. These engravings are not to be judged of as picturesque representations—they were not intended as ornaments, nor were they selected as being the most beautiful: the design being to mark the characteristic features of the scene, not as a landscape, but as a mineralogical delineation.

C O N T

renders them the more valuable. The mineralogical plates and of which contained in elucidating several curious facts, which otherwise would with difficulty have been understood. These engravings are not to be judged of as picturesque representations—they were not intended as ornaments, nor were they selected as being the most beautiful; the design being to mark the characteristic features of the stone, not as a landscape; but as a mineralogical delineation.

C O N

CONTENTS.

VOLUME I.

INTRODUCTION.

CHAP. I. <i>From Edinburgh, by Glasgow, to the Craig of Ailsa.</i>	Page 1
CHAP. II. <i>Description of the Fossils mentioned in the preceding Chapter.</i>	10
CHAP. III. <i>ARRAN. Size and Situation of the Island. Cliffs, Mountains, Surface, &c. Brodick Bay, and its environs ; comprehending Cory-gills, Glen-Cloy, Glen-Sbirreg, Goatfield, and Glen-Rosa.</i>	16
CHAP. IV. <i>Description of the Fossils mentioned in the preceding Chapter.</i>	44
CHAP. V. <i>Cory, Cock of Arran, and Lock Ranza.</i>	67
CHAP. VI. <i>Description of the Fossils mentioned in the preceding Chapter.</i>	87
CHAP.	

CHAP. VII. <i>Glen-Catacol, Glen-Ersay, Glen-Clachan, Shif- kin, Tory-Lin, Benin-Head, Whiting Bay, Lamlass Bay, and Lamlass Island.</i>	- - -	Page 94
CHAP. VIII. <i>Description of the Fossils mentioned in the preceding Chapter.</i>	- - -	116
OBSERVATIONS to be made for the farther Elucidation of the Mineralogical History of Arran.	-	123
CHAP. IX. <i>Outline of the Mineralogy of the Island of Bute; with Observations upon the Formation of the Bed of the Clyde, and an Account of the Route from Bute to the Island of Jura.</i>	- - -	128
CHAP. X. <i>Outline of the Mineralogy of the Islands of Isla and Jura.</i>	- - -	148
CHAP. XI. <i>Description of the Fossils mentioned in the pre- ceding Chapter.</i>	- - -	178
CHAP. XII. <i>Voyage from Jura to the Slate Islands of Seil and Easdale; thence to Oban and the Island of Mull.</i>	- - -	191
CHAP. XIII. <i>Outline of the Mineralogy of the Island of Mull.</i>	- - -	202
CHAP. XIV. <i>Description of the Fossils mentioned in the preceding Chapter.</i>	- - -	225
CHAP. XV. <i>Observations on the Method of Discovering Coal.</i>	- - -	236
		INTRO-

CONTAINING

AS I shall frequently have occasion to mention in this work the division of rocks into Primary, Transition, and Stratified, it may be useful to many to know the characters by which these different rocks are distinguished. I am the more anxious to do this, as we have not, as yet, in any English publication, an account of the division. To this I shall add a few geognostic observations upon the different rocks to be found in the Scottish
isles.

isles, and in those parts of the Mainland which are mentioned in the following Outline.

According to the latest observations, all the strata, of which our globe is composed, may be arranged under the following classes: The Primary, (Urgebürge); the Transition, (Übergangsgebürge); the Stratified, which comprehends what are called the secondary strata, (Flötzgebürge); and the Volcanic, Alluvial, (Aufgeschwemmte.)

I shall now mention the distinction between these different kinds of strata; and, first, of the

PRIMITIVE.

These strata are characterised by their never containing the remains of animals or vegetables, nor alternating with such strata as contain these relics. Humboldt has also observed that the primitive strata in Europe are always inclined towards the N. E., while the strata of the secondary mountains dip towards the S. E.

It is to the celebrated mineralogist John Gottlob Lehman that

that we are indebted for the very important discovery of the division of mountains into primary and secondary. Since he wrote, succeeding mineralogists have confirmed the truth of his observations, and have thus raised geology, from a vague and confused state, to a high pitch of certainty and utility. A few writers have tried to overturn this distinction, *by asserting that it is fanciful*; yet these speculations, like all others not founded on truth and accurate investigation, have sunk into deserved oblivion.

The primitive strata are the following: granite, gneiss, micaceous schist, ardesia, sienite, porphyry, primitive limestone, primitive greenstone, greenstone schist, serpentine, quartz, pitchstone, and topaz rock. Granite is considered by Werner as the fundamental rock, or that upon which all others are laid, and it is but very rarely that it alternates with other rocks. It is disposed in layers or strata, which are often enormously thick, and frequently horizontal, and extend thus for many miles through a whole chain of mountains. All the other primary strata alternate with each other, but never with the transition or stratified rocks. The greenstone, wacken, and pitchstone are the only exceptions; the two first being common to the three first-mentioned formations, but the pitchstone only to the primary, and stratified, or flötzgebirge. The

TRANSITION, OR UBERGANGSGEBURGE

comprehend all those rocks, the lowermost strata of which contain few or no petrifications; in the higher they are more abundant; but only petrifications, the originals of which no longer exist. These mountains also abound in metallic veins and in grottos. Those of Antiparos, Crete, &c. are in this kind of rock; as are the Hartz metalliferous mountains, and those of Derbyshire. They seem to have been formed after the primitive, and earlier than the stratified (flotzegebürge) rock. The strata of this formation are the following: grawacken, grawacken slate, sandstone, some species of ardesia, greenstone, mandelstone, limestone, and Dr Reufs conjectures that some species of sienite and porphyry* may belong to this class of rocks. The

STRATIFIED (*Flotzegebürge*)

appear to have been formed after the transition rocks. They consist of sandstone, limestone, argillite, with numerous petrifications;

* Mineralogische Geographie von Bohmen, 2 Band, § 177.

factions ; also, basalt, shistose porphyry, pitchstone, greenstone, wacken, and the various coal strata.

From the view of these three formations, we observe that the greenstone and wacken occur in every one of them, but the basalt is peculiar to the stratified rocks. The

VOLCANIC

comprehends the various stony substances altered by action of fire : these are, lava, pumice, volcanic ashes, and volcanic tuff. The

ALLUVIAL

consist of gravel, sand, clay, &c. and are the debris of the other strata.

Having thus mentioned the division of the different rocks, according to their relative antiquity, I shall now make a few general geognostic observations on the rocks of the Scottish isles, &c. I shall first mention the

PRIMARY ROCKS.

GRANITE. This rock forms but a small portion of the Scottish isles, it being found only in the isle of Arran, and in the low part of Mull called Rofs, and in the Shetland islands. Upon the Mainland, however, I observed it forming mountains in Sutherlandshire, a considerable part of the county of Aberdeenshire seems to be formed of it, and also the lofty mountain of Cruachan upon the west coast. Granite veins are pretty frequent in several of the islands, as in Arran where they traverse the common granite, and in Coll, Tiree, Rona, the Orkney and Shetland islands, &c. where they traverse micaceous shistus, gneiss, or hornblende slate. Upon the mainland, in the route from Bernera to Perth, the granite veins are extremely common.

GNEISS. This rock I observed in Coll, Tiree, Rafay, Rona, in the Shetland islands, and in several places upon the Mainland of Scotland; in particular it forms the summit of the high mountain called Ben Lomond. It sometimes alternates with micaceous shistus and hornblende rock, and it is traversed by granite veins, as is the case in Coll, Rona, &c.

MICACEOUS SHISTUS. This rock forms a portion of the isles
of

of Arran, Bute, and Mull; it is just to be observed in Coll, but a very considerable extent of the Shetland islands are composed of it. In the Mainland it appears to extend through the whole district of Cowal, and to the extremity of the isthmus of Cantyre, and in all the country from Bernera to Dunkeld; and from Dunkeld to Loch Lomond by Inveraray, the micaceous shistus is the prevalent rock. Upon the east coast it is frequent among the other primary strata. It alternates with shistose quartz in the island of Mull, and with hornblende and gneiss in the island of Coll; and it is to be observed in several places passing to ardesia, and it is traversed by granite veins, and has pieces of granite enclosed in it.

ARDESIA. Primitive argillaceous shistus. This rock occurs in Arran, Bute, Isla, Jura, Easdale, and Seil. In Isla there is a species of it which contains pieces of granite, which, however, seem to have been formed at the same time with the ardesia. In Easdale, Seil, Bute, and Arran, it is quarried for economical purposes; but the slate of Easdale is by far the best.

SIENITE. A rock nearly allied to sienite seems to form the craig of Ailfa; it also forms part of the island of Arran, and the lofty Cullin mountains in the island of Skye.

POR-

PORPHYRY. I observed fragments of porphyry among the granite mountains in the island of Arran, which is probably of primitive formation, and the porphyry, which forms so considerable a part of the hill of Glamofcard in Skye, seems to be of primitive formation.

PRIMITIVE LIMESTONE, or MARBLE. This rocks occurs in vertical strata at I-columb-kill, also in the island of Tirie, and in several parts of the Mainland. I observed it alternating with primary rocks, particularly at Portfoy, where it is in vertical strata and alternates with talcaceous shistus and serpentine.

PRIMITIVE GREENSTONE. I have not met with this rock in any part of Scotland excepting in the island of Ilay, yet I think it very probable that a careful examination may discover it in many places.

SERPENTINE. There are no strata of this rock in the Hebrides, nor the Orkney islands; but in Shetland it forms extensive hills, and there it seems evidently to be of primitive formation. At the interesting spot, Portfoy, there are great vertical strata of serpentine alternating with marble, talcaceous, and hornblende shistus.

QUARTZ.

QUARTZ. In the islands of Isla and Jura there are mountains of granular quartz, and it is there to be observed alternating with, and passing into micaceous schistus. In the isle of Coll there are also considerable rocks of granular quartz. In the island of Tirie I observed the rare appearance of a vein of granular quartz traversing strata of micaceous schistus and hornblende slate. In Caithness the mountain of Scaraban is composed of quartz; and at Portsoy there is a hill which affords schistose quartz. In many places veins of quartz are to be observed traversing the primary strata, and in the island of Bute there is a quartz vein which presents appearances irreconcilable with the Plutonic theory.

PITCHSTONE. The only species of this stone which I have ever seen, that may be considered as primary, is that upon the hill of Glamofcard in the island of Skye. It there seems to alternate with porphyry, but of this I am not as yet certain. In the island of Arran there are appearances of pitchstone in the form of veins traversing the granite, but as all veins are of an after formation to the rocks which they traverse, this cannot be reckoned equally old with the granite, or other primitive rocks.

TRAN-

TRANSITION ROCKS, (*Uebergangsgebürge.*)

GRAWACKEN. This is a rare rock in the districts through which I passed. The only appearance I ever noticed was a small portion lying on ardesia in the island of Seil.

GREENSTONE. The greenstone of the island of Mull appears to belong to this formation, as it is found near to limestone that contains belemnites.

LIMESTONE. This species is found in the island of Mull, and contains in it cornu ammonis and belemnites; hence I reckon it to belong to the transition rocks.

STRATIFIED ROCKS, (*Flötzgebürge.*)

SANDSTONE. Of this I observed two kinds, the filiceous and argillaceous.

The filiceous does not frequently occur. The sandstone of the island of Rume approaches nearly to this kind, and in the Orkney islands there are strata of filiceous sandstone that alternate

ternate with argillaceous sandstone. Argillaceous sandstone forms the Cumbray islands, the south extremities of Bute and Arran; and it also appears in the islands of Seil, Mull, Eigg, Skye, Rasay and Scalpa. Almost the whole of the Orkney islands are composed of argillaceous sandstone, but it forms a very small portion of the Shetland islands. It also skirts the east coast of Scotland from the Pentland Firth to the small fishing town called Buckie; and again this sandstone makes its appearance near to Aberdeen, and continues along the shore all the way to the Frith of Forth.

LIMESTONE. In the island of Arran there are considerable strata of limestone which is covered by argillaceous sandstone; and in some places the limestone and sandstone alternate. In the Orkneys limestone is to be observed covered by sandstone, and even traversed by veins of sandstone.

ARGILLITE with numerous shells is found in the island of Arran, and in the island of Eigg.

BASALT. This rock, which, as we have before observed, is peculiar to the Flötzgebürge, is found in almost every part of Scotland, either in strata, or in veins. I observed it disposed in strata in the island of Seil, at Oban, in the islands of Mull, Eigg,

Eigg, Canna, and Skye; and these strata either alternate with argillaceous sandstone, wacken, or greenstone. Frequently also veins of basalt traverse these strata.

BASALT VEINS. These veins are extremely common in most of the Hebrides, but are rarely to be observed in the Shetland or Orkney islands. I observed them traversing granite, gneiss, micaceous schistus, sienite, porphyry, hornblende slate, sandstone, and limestone. In the island of Arran there are several very remarkable veins which are partly formed of basalt. Thus in Glencloy there is a vein, (traversing clay porphyry), which is composed of basalt in the middle, but, upon one side is sandstone breccia, and, on the other is hard siliceous sandstone. At Tormore, upon the west side of the island of Arran, there are several other very remarkable veins partly formed of basalt.

BASALT TUFF. I observed this rock at Dumbarton castle, and in the islands of Mull and Canna, where it always accompanies rocks of trap formation. In the island of Canna it is remarkable for having pieces of wood inclosed.

PITCHSTONE. This curious fossil is found very frequently in the

the island of Arran, but generally in the form of veins. These veins traverse the common argillaceous sandstone, and are often of great magnitude. It is also disposed in stratified veins along with other substances at Tormore in Arran. In the island of Mull it seems to lie between sandstone and basalt; but in Eigg it forms considerable veins traversing basalt. This fossil, which was before considered as very rare, is thus shewn not to be so uncommon; and I have lately learned that it has been observed in veins traversing sandstone in Morven, and in veins traversing basalt at Ardnamurchan.

GREENSTONE. The country between the primary strata at Dunkeld, and the banks of the Frith of Forth presents many appearances of flötz greenstone; and, in the same tract there is also wacken of a similar formation.

COAL. In the island of Arran there is a stratum of blind coal inclosed in sandstone. In Mull, Eigg, Canna, Skye, it is observed always stratified with basalt or wacken.

VOLCANIC ROCKS *

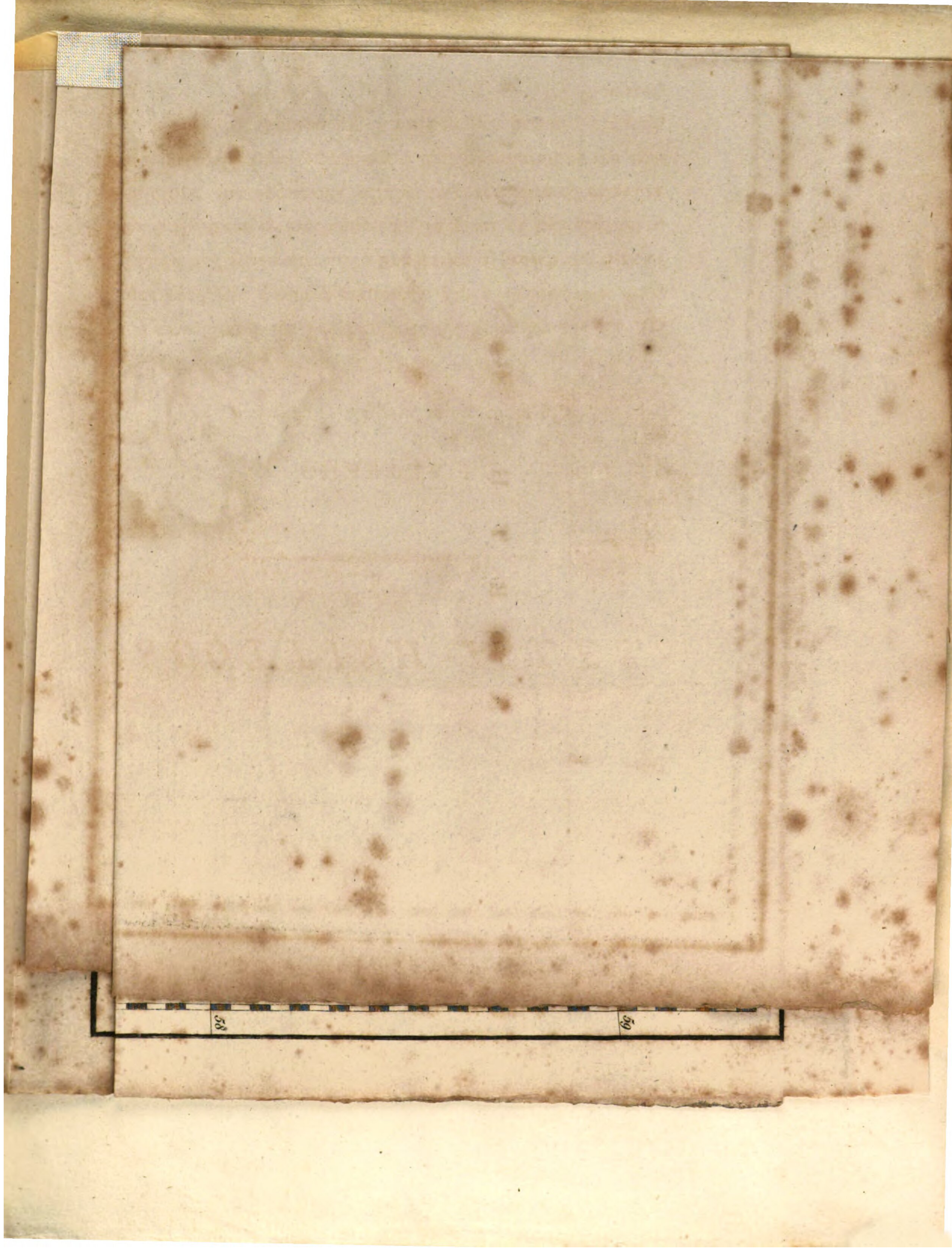
have never been discovered in Scotland.

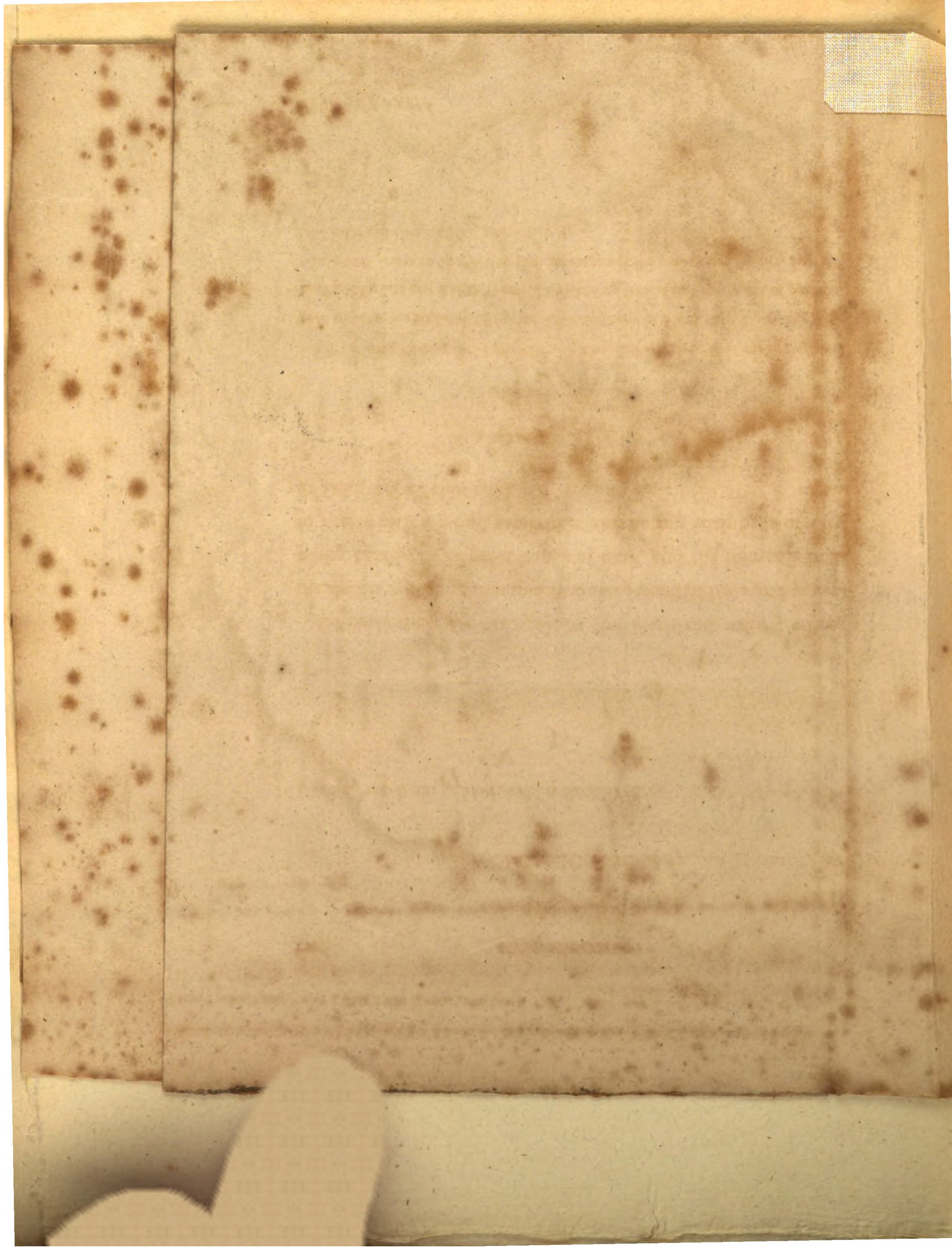
ALLUVIAL.

Of these there are examples in the Highland vallies, where the debris from the mountains are deposited in beds and covered by heath. The great banks of sand, and the immense beds of peat which we find sometimes alternating with beds of clay or sand, are of this kind.

MINE-

* Of the pseudo-volcanic rocks, which are different species of rocks that have been exposed to accidental fire, we have instances in Fifeshire. Upon the shore between Dyfart and Easter Wemyss I picked up several fine specimens of porcellanite, which seems to be the clay that accompanies the coal altered by fire, as masses of scorix and charcoal still adhered to it.





MINERALOGY
OF THE
SCOTTISH ISLES.

CHAPTER I.

From Edinburgh, by Glasgow, to the Craig of Ailsa.

IN travelling from Edinburgh to Glasgow, by the Livingstone road, the country continues, for a considerable way, pleasant and well cultivated; but as we approach the Kirk of Shotts the scene is much altered. In place of inclosed fields, exhibiting the operations of thriving agriculture, extensive moss grounds appear, forming a striking contrast to the cultivated country through which we had just passed. Happily, however,

however, these mosses are now viewed in a more favourable light than heretofore: the brown burnt-like aspect of a peat moor does not now strike the mind with ideas of bareness and sterility; as we know, from experience, that labour and a little expence may soon convert them into luxuriant fields.—A few miles after passing this desert, we come in sight of Glasgow; but its low situation, and the want of hills, render it, when compared with Edinburgh, far less interesting as a picturesque object. The nearer we approach the town the country improves, and is considerably diversified with wood and cultivated fields.

The rocks which occur in this tract are all of secondary formation; which is commonly the case where the country is low and flat. As our journey was rapid, I can only say, in general, that the strata are, sandstone, limestone, basalt, wacke, mandelstein, coal, with its accompanying shistose clay, &c. and iron-stone.

The sandstone is generally used for the purposes of building; but, from different quarries it is more or less durable. This fact leads us to remark, that chemical trials, combined with correct mineralogical observations, might, in many instances, enable us to determine, with some certainty, as to the probable

probable durability of stones employed in building. Indeed, those who have been long in the habit of analysing and examining such stones, can, even by their appearance, judge of their probable durability *: a circumstance sufficient to encourage us to pursue a mode of investigation which has hitherto engaged little attention.—The limestone which occurs in this district varies considerably in its appearance: but we had not an opportunity of observing it particularly. It is quarried in several places to a considerable extent, and then burnt, and used for manure, and for building. It is burnt for these purposes in the common draw-kiln, which is ill constructed, as there is not only a great waste of heat, but, by exposure to all the variations of the weather, the burning is rendered precarious and uncertain. My father remedied these defects in a kiln which he built eight years ago, and which he still conti-

A 2

nues

* We have a curious instance of this related of the late Mr Bayen; a gentleman who had paid much attention to the genera of marble and serpentine. Walking one day in the Place de la Revolution, at Paris, with his friend and colleague Deyeux, he pointed out to him several of the marble pillars, which, he said, notwithstanding their present solid appearance, would decay in a short time, and in the particular places he mentioned. Accordingly, a year had scarcely elapsed when his prediction was fulfilled: many of the pillars began to decay, and even considerable hollows were quickly formed in some of them.—*Annales de Chymie.*

nues to use as economical, both with regard to time and fuel. It differs from the common kiln by having the body or cylindrical part very deep, and covered with a dome, which is connected with a vent that has a damping plate, so as to allow a very advantageous management of the heat. Besides, it has another very considerable advantage over the common kiln, that is, it can be erected in a town without detriment to the neighbourhood, as all the noxious matter is carried away by means of the chimney †.

The country in the neighbourhood of Glasgow, as far as I had an opportunity of examining, is composed, not, of basalt, which

† A vulgar prejudice has long prevailed, that the noxious matter of limestone is more dangerous than that of common coal; and the many horrid stories on record, of sudden deaths in the neighbourhood of lime-kilns, still continue the delusion with the ignorant.—The modern chemical discoveries have shown, that common coal, bulk for bulk, furnishes more of the noxious matter (carbonic acid and carbonated hydrogen) than limestone: therefore, the noxious effects of the common kiln does not depend on any peculiar malignity of the vapour which issues from the stone, but upon the construction of the furnace.

The patriotic Count Rumford has lately proposed a new plan of a lime-kiln, which certainly deserves to be tried: To us it appears objectionable, not only from the close attendance that the fires require, but also that a considerable portion of heat is lost by its being open at top.—See *Rumford's Essays*.

which has sometimes in-lying crystals of felspar, basaltic hornblende, augit, leucit, mica, and a few interspersed particles of quartz; 2. basalt porphyry; 3. grunstein; 4. limestone. The short time I could afford to spend in Glasgow, and my anxiety to get forward to the Islands, prevented me from examining the relation of the different strata to each other; which, however, I the less regret, as that circumstance is but slightly connected with my present object.

Professor Faujas de St. Fond has given us a short account of the mineralogy of the environs of Glasgow; but his descriptions are unluckily obscured by a rigid adherence to a theory which has no foundation in nature. He considers all the rocks we have now mentioned, as lavas; and those he denominates basaltic, porphyritic, and granitic lavas. I do not hesitate a moment in saying, that, in my opinion, there is not in all Scotland the vestige of a volcano. I do not rest this assertion upon my own authority, (for that would be presumptuous;) but upon that of Dr. Walker, who has examined more of the mineralogy of Scotland than any man now living, and whose collection of Scotch fossils is the largest that has ever been made. Besides, it wars with every principle of systematic classification, to arrange and denominate fossils from any *theory* we may adopt as to their formation.

We

We now pursued our journey from Glasgow to Greenock, down the river Clyde: a voyage which presents the traveller with many scenes of uncommon beauty. At Glasgow the river is narrow, with low formal banks; but as we approach Dumbarton, the river becomes wider, the country more beautiful, and the scene is soon rendered interesting by the appearance of the singular rock of Dumbarton. From this the mountains of Cowal extend, along the north side of the river, to Rosneath; forming a fine contrast of Alpine wildness, with the comparatively low green hills which reach to Greenock upon the south side of the river. The strata between Glasgow and Greenock, upon the south bank of the river, are, sandstone, limestone, basalt, and wacken. Those of the north bank, to the town of Dumbarton, continue to be nearly of similar rock; forming, in this rout, some considerable heights, particularly about Frisky Hall, where the rocks have a fine terraced appearance. Immediately below the house of Frisky, at the porter's lodge, we observed a small quarry of wacken, which is now celebrated as affording fine specimens of prehnite. The town of Dumbarton is situated in a plain of considerable extent; and the rock upon which the castle is built, rises from it in a similar manner with Arthur's Seat, near Edinburgh, but is much more striking, from the great flatness of the country. It is composed of black basalt; but, upon the side facing the town,

we

we observed a basalt tuff covered by sandstone. Professor St. Fond remarks that this rock is formed of a black basaltic lava; but upon the lower part, facing the town, there is to be observed a current of muddy lava, having, intermixed, fragments of basalt, more or less altered.—At different periods the rock of Dumbarton has been of considerable consequence, on account of the strong fortress which is built upon it. When Mary, the unfortunate and lovely Queen of Scotland, was imprisoned in England, and her kingdom wrested from her, the solitary rock of Dumbarton held out against every attempt to take it; and was the only place in the kingdom that dared to acknowledge her authority.

If we glance over the country as it extends towards Lochlomond, we observe it rising gradually until the prospect is bounded by vast mountains, marking, by their height and shape, a change in the nature of the strata, and forming the grand entrance into the Highlands upon this side of Scotland. If we examine the country more particularly, we find our conjecture right; for at Luss, upon the banks of this beautiful loch, strata of micaceous schistus, and other primitive rocks, make their appearance. These strata extend towards the Clyde, and form a considerable part of its north bank, from Dumbarton to Rosneath, a small village opposite to Greenock.

Greenock,

Greenock, a populous and flourishing town, is situated upon the side of the river, at the bottom of hills of considerable height; and remarkable for the quantity of rain which falls during the year, which is said to be more than in any other part of Scotland. The strata in the immediate vicinity of the town are, basalt, wacken, sandstone, limestone: and in some places the sandstone is to be observed traversed with basaltic veins; and the wacken, besides zeolite, contains a curious fossil nearly allied to leucit.

From Greenock our farther progress down the Clyde was more interesting, from the grandeur and variety of the objects which now occupied our attention. After passing the Gourock lighthouse, we observed the beautiful island of Bute, with the neighbouring and Cumbray isles stretching across the view; and, farther distant, the wild mountains of Arran appeared over the low part of Bute towering among the clouds. The hills upon the opposite bank of the river are strikingly contrasted. Upon the Cowal shore the country rises into considerable hills of micaceous schistus, which are partly heath-clad, and join with the bare and sterile mountains that extend from this shore through Argyleshire. Upon the opposite bank of the river the country is much lower; there are no steep hills upon the shore; and the strata, which are horizontal, are, red and
white

white-coloured argillaceous sandstone, sandstone breccia, basalt, and frequently basaltic veins traverse both these strata. The breccia, as is often the case with this kind of rock when it occurs upon the sea-shore, forms beautifully wooded cliffs, which extend to the sweetly-retired village of the Largs. These secondary strata extend from the Largs to Saltcoats, and from thence far through Ayrshire; while the primary rocks, on the opposite bank of the river, appear to extend to the Mull of Cantyre.—In a few hours after passing the Cumbray isles, and the majestic island of Arran, we landed upon the great rock which is called

THE CRAIG OF AILSA.

This stupendous rock is said to be 400 feet high, and is about two miles in circumference. It is somewhat of a conical shape, and very precipitous on all sides: the only landing-place being on the N. E. where there is a small beach, formed by the fragments which have fallen from the neighbouring rocks. It is much lower now than it was formerly; as is evinced, not only by the numerous fragments lying on the beach, but also more fully by the nature of the bottom near it, which, according to the most accurate soundings, is gravelly to a considerable distance.

B

After

After having walked around part of it, and ascended near to the summit, I was forced to return, as the captain of the vessel was anxious to proceed to Arran. On this account, I was prevented from examining it so accurately as could have been wished. This glance, however, was sufficient to satisfy me as to the general nature of the rock of which it was composed.

The greater part seems to be formed of different species of very compact sienite; which, particularly on the east side, presents immense groupes of columns, similar in appearance to the basaltic columns that occur so often in different parts of Scotland. In ascending towards the summit, and a little below the solitary ruin of a castle, I observed two considerable basaltic veins traversing the sienite.

C H A P.

C H A P. II.

Description of the FOSSILS mentioned in the preceding Chapter.

PREHNITE—*Friskey-Hall.*

SILEX PREHNITES, Wern. *HALB ZEOLITH*, Esthner. *BOSTRICHITES*, Dr. Walker.

It is either in flat masses, cellular, or botroidal, or partly assuming a mammillary figure; is generally radiated and composed of small prismatic crystals—sometimes so small, and so near to each other, as to assume, in some degree, a compact texture, almost resembling chalcedony.

Colour. Varies, from apple green, to yellowish green, pale yellow, and white; but, when affected by the weather, it acquires an ochry, or opaque white colour.

Lustre. The external lustre little glancing*; internal is pearly.

Transparency. It is semi-transparent; but, when acted upon by the weather, it becomes considerably opaque, and much resembles certain species of sulphat of barytes.

Hardness. Gives sparks with steel; takes a pretty good polish.

B 2

Fracture.

* *Wenig glänzend.* Germ.

Fracture. The fracture in the direction of the foliæ appears foliated, but across the radii approaches to the conchoidal.

Fusibility. Dr. Hope melted it, and, by slow cooling, had again a pretty regular crystalline texture.

It is contained in a species of wacken, which, by its degree of induration, appears passing to the state of basalt. It is frequently accompanied by calcareous spar. Another substance is often found with it, which is probably of the nature of zeolite.

It is formed of long prismatic radii, which have the following character.

Colour. White.

Lustre. Pearly.

Transparency. Nearly transparent.

Hardness. Difficultly scratched with a knife.

OBSERVATIONS.

The Prehnite has received many denominations, by different mineralogists: thus it has been called green felspar, apple-green quartz, filiceous zeolith, cape-chrysolith, emerald, prase, and crysopræse:—a striking proof of the imperfection of mineralogical nomenclature. The justly-celebrated Mr. Werner, to whom

whom we owe so much of our most accurate information, names it Prehnite, after Colonel Prehn, a Dutch officer, who found it at the Cape of Good Hope, and first brought it to Europe. Since its discovery at the Cape of Good Hope, it has also been found in Dauphiné; and Dr. Groscke of Mittau first discovered it at Frisky-Hall. This is not the only place in Scotland where this beautiful fossil is found; for I have observed it in the castle rock and Arthur's Seat at Edinburgh, and we shall afterwards notice it in the island of Mull.

LEUCIT—*Greenock.*

SARCITE, Dr. Townson's Tracts in natural history. BORAX

MARGODES, Lin.?

This fossil is of a reddish-brown colour, and generally crystallised in the form of a 24 edron: it is also, in some instances, amorphous, with an earthy fracture*.

It has always occurred opaque, and of such a hardness as to yield with difficulty to the knife.

With the blow-pipe it loses its colour, and melts like felspar.

It

* Dr. Hope has in his possession a very fine specimen of this fossil, which he found at the Calton Hill. Dr. Townson has figured it in his Tracts.

It is found in the cavities of wacken, and sometimes imbedded in calcareous spar.

Abbé Huay remarks that this fossil is considered as a zeolite †; and La Metherie, who had examined specimens of a similar fossil from the Calton-Hill at Edinburgh, remarks, “ On trouve, au mont Calton-Hill, proche d’Edimbourg, un cristal à vingt-quatre facettes trapezoidales, comme celui-ci. Il est rougeatre, poreux, terne, comme de la brique.—On croit qu’il doit entrer dans la zéolite leucitique ‡.” Dr. Townson, in his lately-published Tracts in natural history, considers it as a new genus, and names it Sarcite: this, however, cannot be admitted, until the fossil shall be regularly analysed. Mr. Camara of Lisbon, a most intelligent mineralogist, informed me, that he had frequently met with this fossil in other countries, but always considered it as nearly allied to leucit. It appears, then, that it should still be reckoned of the nature of leucit, until it shall be more particularly examined in the way of chemical analysis.

SIENITE—

† Annales de Chymie.

‡ Th. orie de la Terre, tom. 2de, p. 308.

SIENITE—*Craig of Ailsa.**CALOMACHUS*, Dr. Walker's *Classes Fossilium*.

So far as I can determine at present, this rock appears to be a very compact species of sienite, in which the felspar is the most prevalent ingredient. Sometimes the felspar seems passing to the state of earthy felspar; and then it forms a basis in which we observe red or white-coloured crystals of common felspar and hornblende, and particles of quartz: thus forming a species of sienitic porphyry.

ARRAN.

A R R A N.

C H A P. III.

*Size and Situation of the Island. Cliffs, Mountains, Surface, &c.
Brodict Bay, and its Environs; comprehending Cory-Gills, Glen-
Cloy, Glen-Shirreg, Goatfield, and Glen-Rosa.*

THIS island is about thirty-two miles long and twelve broad; situated in the mouth of the Frith of Clyde, about eight miles from Bute, and sixteen from Saltcoats in Ayrshire. Its shape is irregular, but not so much so as many of the Western Islands which are exposed to the Atlantic Ocean. Here, the vicinity of the Scottish and Irish shores prevents any great destruction of land; as is evident from the lowness of the cliffs round the island, which have not the precipitous, rugged and bold aspect of many of the Western Islands.

CLIFFS. The cliffs are seldom above two hundred feet high; are generally precipitous: having frequently, however, an intervening

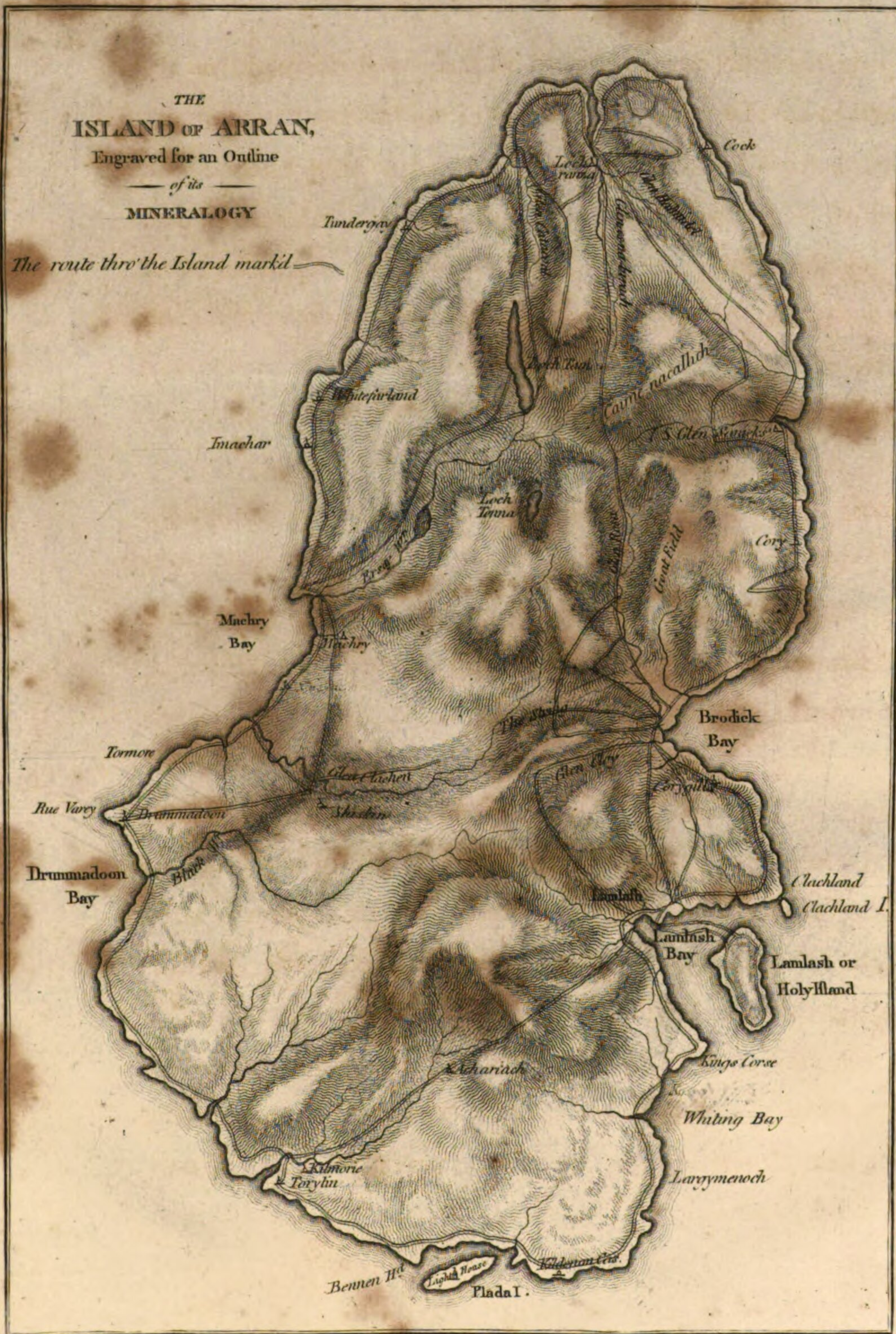
ISLAND OF ARRAN,

Engraved for an Outline

— of its —

MINERALOGY

The route thro' the Island mark'd.



tervening bank between the cliff and the sea, formed by the destruction of the rocks, which are either of sandstone or micaceous shistus. Considerable sandy beaches frequently occur, formed of the debris of granite, sandstone, and micaceous shistus; and sometimes we remark a considerable extent of coast covered with enormous masses, which have been torn away by torrents, or separated from the neighbouring rocks by the vast expansive power of frost.

MOUNTAINS. No regular ridge of mountains is to be observed: these being either in the form of groups, as Goatfield and the adjacent mountains, which present astonishingly grand peaked summits; or irregular, forming round-backed hills, as those towards the south part of the island.

SURFACE. The land is in general very high, particularly towards the north end, where the wonderful group composed of Goatfield, Caime-na-callich, &c. present mountains near 3000 feet high. Here Nature exhibits to the astonished eye the most terrific and sublime scenery; to convey even a faint idea of which would require an able pen. The southern parts are lower; and in place of the bare rocky appearance of the north, we have heath-covered hills, and a considerable portion of cultivated land.

The island is divided into two parishes, Kilbride and Kilmory, belonging to three proprietors; the Duke of Hamilton, Marquis of Bute, and John Fullerton, Esq. of Kilmichael; and yields about 5000 l. of yearly rent. This indeed might be much increased, were proper methods of cultivation followed; and were long leases and larger farms properly granted, more happiness, industry and wealth would be the natural consequence.

In describing the island particularly, I shall begin with

BRODICK BAR, situated on the east side. This beautiful bay is bounded, on the S. by the hills of Cory-gills; on the W. by the vales of Glencloy and Glenshirreg, and, on the N. the tremendous Goatfield forms a lofty boundary. It is of an irregular shape; about five miles long, and four broad; having about five fathoms water, with good anchorage ground: but it is only in moderate weather that vessels can ride in safety. From this bay passage-boats go to Saltcoats, about sixteen or eighteen miles distant, which renders this the principal thorough-fare in the island; so that the population is considerable. Many visitors come from the mainland, during the summer months, to enjoy the free air, and admire the wonderful scenery of this interesting island: but the want of a good inn is much to be regretted.

regretted. On the north side of the bay stands Brodick Castle, an old ruinous building, inhabited occasionally during part of the summer by the Duke of Hamilton. It is situated upon the side of Goatfield, commanding a most extensive and delightful prospect; and might easily be made a beautiful seat. About two miles distant, in Glencloy, is situated the pleasant seat of the worthy and most hospitable family of Fullerton, of Kilmichael, who have now resided in the island upwards of 700 years.

Mineralogy. The mineral history of this part of the island is, in many respects, interesting; not only on account of the variety of fossils which it affords, but also in presenting to us, in a short space, a representation of the structure and materials of nearly the whole island. On this account I shall be minute in my description; as I may have occasion to refer to this particular part, when describing the other quarters of the island.

The south side of the bay is low immediately upon the shore: it however rises gradually; forming the hills in the neighbourhood of Cory-gills, and, towards the sea, cliffs of considerable height, almost entirely composed of sandstone*. This sand-

C 2

stone

* M. de C. Laffone has observed, that the surface of a sandstone, which had
the

stone is pretty compact, of a reddish colour, much resembling that found in Shetland; and is here and there alternated with strata of breccia, composed of rounded fragments of quartz, with fragments of sandstone, of various sizes and shapes; and both these strata run at an angle of from 10° to 15° . In many places there are very considerable veins of basalt, or what have been called Whin-dykes †, crossing the sandstone in various

the year before been left uncovered, was invested with a filiceous crust, nearly as hard as agate: the particles of which it was formed must therefore have been conveyed and deposited by water. *Mem. Par. 1774. Kirwan's Geological Essays, p. 112.*—This is a proof of the solubility of filiceous earth in water: a fact denied by the Plutonists. It is more demonstrably confirmed by the following fact, from Mr. Kirwan's Geological Essays, p. 140. “About the year 1760, the Emperor of Germany being desirous to know the length of time necessary to complete a petrification, obtained leave from the Sultan to take up and examine one of the timbers of Trajan's bridge over the Danube at Belgrade. It was found to have been converted into agate to the depth only of half an inch; the inner parts were slightly petrified, and the central still wood.”

† The term Whinstone, like many other popular denominations, does not convey a distinct idea of any particular genus of fossils; but is used by the inhabitants of Scotland, and of the north of England, to express those fossils which are of *trap formation*. Mineralogists, in many instances, appear to have used it in a very vague manner: thus some describe trap, others basalt; and not unfrequently wacken, greenstone and indurated clay have been arranged under this name.

rious directions. Some may be observed rising from the sea, and penetrating the sandstone. In other places, where the superincumbent sandstone has been completely carried away, veins can be remarked running, with little variation in diameter or direction, for nearly a mile. These veins are not only to be observed upon the sea shore, but can be traced running, in various directions, and of different diameters, through the sandstone and other rocks in the interior of the island, as we shall afterwards clearly demonstrate. In ascending the hill towards Cory-gills, a very considerable vein of dark leek-green pitchstone makes its appearance, running from the cliffs upon the shore, thro' the sandstone, to the Lamlaish road, where we soon lose it among the sandstone in the neighbouring hills. This vein is of various breadths; in some places, as at the Lamlaish road, being about eight feet. It does not appear to have altered the sandstone, where it is in contact with it; but, in some parts of the vein, the pitchstone, as it approaches the sandstone, loses much of its lustre, and, in fracture and hardness, approaches to the nature of basalt.

The name. It is much to be wished that it could be entirely laid aside; particularly when we perceive that the great Werner has framed satisfactory characters for these different rocks.

The appearance of pitchstone in the form of veins, and in secondary strata, has not as yet been observed by other mineralogists. Mr. Werner, from his own extensive knowledge, and the accumulated information of his numerous pupils, is of opinion, that pitchstone is always disposed in strata, and entirely confined to primitive mountains. The late Abbé Spallanzani describes several veins of pitchstone lava that he observed in the Euganean mountains; but it is difficult to determine with certainty whether this be the true pitchstone*.

Higher up, above the houses of Cory-gills, I observed a number of columns which are composed of clay-porphry. These pillars are in various directions: some are perpendicular to the horizon; others more or less inclined; and I observed, farther up, that they are quite horizontal. They are in the form of four or six-sided columns, from six to ten feet long, and two or three feet in diameter, having a whitish crust from decomposition. They are not jointed; nor is there any appearance of balls, or what the volcanists call *volcanic bombs*. I endeavoured to discover the position of the porphyry with regard to the sandstone, but could not detect them in contact with each other; yet, from the nature of the rocks

all

* Spallanzani's Travels in the Two Sicilies, vol. 3d, p. 251, &c.

all around, I am inclined to believe that it rests on the sandstone. In descending from this porphyry hill towards Lam-lash, the sandstone again makes its appearance, but is soon lost; being covered with a rock which is principally composed of dark-green coloured hornblende, with a little felspar and quartz, and answers nearly to the greenstone of the Germans. This greenstone forms the summits of several hills in the neighbourhood, and may be remarked running towards the sea, forming high cliffs. In one place I observed a great body of green-coloured pitchstone, which runs quite in an opposite direction to the vein I observed crossing the Lam-lash road: in short, it appears to be stratified, and to run immediately below the greenstone. About twenty yards lower, another mass occurs, about ten or twelve feet thick; and which, so far as I could determine, appears to form a stratum, running between the sandstone and greenstone. I was informed that this mass of pitchstone had been traced to the face of a high cliff upon the sea-shore, where it is said to lie upon sandstone, which also covers it; and that it was there also split into columns, like basalt.

Having now mentioned the position of the veins and strata upon the south side; I shall return to the sea-shore, where we observe

observe the bay rising towards the west, forming the one side of Glencloy.

GLENCLOY. This glen is nearly three miles long, and half a mile broad; open towards the east, but bounded on the other sides by high hills. At the top, or west part, of the glen, the hills are highest, forming a very romantic groupe of rocks. The north and south sides, which are of considerable height, become gradually lower as they approach the sea, where they form part of Brodick Bay. The bottom of the glen rises gently from the sea, forming a small angle with the hills that bound it. Immediately under the peat moss, or heather, we discover boulder stones, which form a thick bed, from three to thirty feet thick; and in other places they are collected together in heaps, being thrown into this form by the force of water. These boulder stones are not of very considerable size, and vary but little in that respect at the top or bottom of the glen; which shews that the greater part of them have not received their rounded form by attrition in the water of the glen, but are derived from decomposed breccia. They consist of granite, porphyry, sienite, breccia and sandstone, which are all to be observed in the neighbouring hills. Through the glen runs Glencloy burn, formed by the springs and rains from the
the

the hills : it is narrow, but, during violent storms, it overflows a considerable part of the glen, and has thus laid bare the rocks, and shows us, in a satisfactory manner, the nature of the subjacent strata. The bottom of the glen is composed of the common red-coloured argillaceous sandstone, and here and there are strata of breccia ; and both are traversed with veins of basalt, which run in very various directions, and are from three to twelve feet in breadth. These veins, in their passage thro' the strata, (to use the Huttonian language,) do not appear to have occasioned in them any alteration with regard to hardness : on the contrary, we often find a species of semindurated clay interposed between the sandstone and basalt, thus forming a stratified vein.

Reufs, the celebrated German geologist, in his mineralogical history of Bohemia, describes two stratified veins which he observed in the Bunzlauer circle. As it is of importance to turn the attention of the young mineralogist to those curious, and, I believe, rare, appearances, I will shortly mention the nature of those veins observed by Reufs. One of the veins traverses argillaceous sandstone, and is about a fathom wide ; its sides are of common argillaceous ironstone, about five or six inches wide : to this succeeds a layer of wacken-clay, about half a foot wide ; then a thin layer of wacken, or rather a rock

D

inter-

intermediate between wacken-clay and wacken; lastly, the middle of the vein is basalt. The other vein has argillaceous ironstone for the *saalband* or fides, but the middle is wacken clay. The sandstone, as it comes in contact with the vein, is remarkably great-grained and iron-short*.

The hills on the north and south sides of the glen are of the same height; and the pente of the hills appears to correspond pretty nearly with the elevation of the strata. The hills on the south side are formed of sandstone and breccia, which, towards the upper end, form very lofty precipices. Many veins of basalt traverse the sandstone, and loose nodules of brownish-black and black pitchstone lie scattered about here and there. On the north side of the glen, near to Brodick wood, a considerable body of dark leek-green coloured pitchstone makes its appearance; but it is so much covered with grass, that it is difficult to say whether it forms a vein or a stratum. It is well worthy the attention of those who may visit Arran, to endeavour to determine this point. In ascending the hills upon this side, after gaining a considerable height, the sandstone disappears, when a clay

* Mineralogische Geographie von Böhmen, von Franz Ambros Reufs, vol. 2.

a clay-porphry is to be observed; and upon the brow of the hill, where the rains, &c. have broken down the porphry, several curious phenomena appear. In the first place, I observed the porphry in columns similar to those at Corygills: next, the basaltic veins running in different directions through it. One great vein is to be observed rising from the neighbouring sandstone, penetrating the clay-porphry; and, as it rises upwards, getting a considerable curve, when it branches: one branch rises to the top of the hill; the other runs but for a short way into the porphry, in the form of a wedge. Near to the same place a curious *stratified* vein makes its appearance, running in an almost opposite direction to that we have just mentioned, and terminating in a wedge-like form. On the upper side it is formed of sandstone breccia; the lower is hard siliceous sandstone; but the middle is basalt.—The west or upper end of the glen is formed of sandstone pretty much traversed with veins of basalt, which are more or less inclined, and of various diameters. Besides this sandstone, we observe lofty precipices of sienite, which form strata elevated at an angle of about 30° . This rock is not only very much varied in the nature of its constituent parts, but also in the degree of intimacy of combination, which renders it very difficult to distinguish its different species. It is also traversed with

veins of basalt, but not so much so as the sandstone*. It forms the higher part of several of the hills betwixt the top of this glen and the Shiskin, and is all along traversed with basaltic veins.

It appears, from the description that has been now given, that the sandstone forms by far the greatest part of the glen; the next in proportion is the porphyry, and lastly the sienite.

The

* Dr. Hutton, in his speculations upon the theory of the earth, remarks, "If it be by means of heat and fusion that strata have been consolidated, then, in proportion to the degree of consolidation they have undergone from their original state, they should, *ceteris paribus*, abound with more separations in the mass. But the conclusion is found consistent with appearances. A stratum of sandstone does not abound so much with cutters and veins as a similar stratum of marble, or even a similar stratum of sandstone that is more consolidated: they are in general intersected with veins and cutters; and in proportion as strata are deep in their perpendicular section, the veins are wide, and placed at greater distances." This does not appear to be consistent with the fact; for it is to be observed, in Arran, that the sandstone contains more veins than the sienite, which last is harder than any sandstone in the island; and we observe that the sienite contains a greater number of veins than the granite, although it be softer and less compact.

The determination of the relative position of strata and veins is the great object of the geologist, and without it his labours will be of comparatively little value. It is, no doubt, of importance to know that a country is composed of particular kinds of rock: yet this will be very unsatisfactory, if we know not whether these rocks be primary or secondary, how they lie with regard to each other, and, consequently, if they be favourable for the appearance of metallic veins, coal, &c. Many travellers, as my friend M. Camara de Bethencourt has observed †, satisfy themselves, in their geological observations, by following a very superficial and absurd mode of investigation. Thus, some are contented to sit in their carriage and view the rocks as they pass along; others, with more apparent curiosity, examine the debris at the bottom of the hills, and, by means of their telescopes, determine the nature of the highest mountain. It is plain that these practices must be very detrimental to the advancement of true geological knowledge: they are the more so, when we consider, that the greatest labour and assiduity is often employed in vain to delineate the true geological character of some parts of a country. In the course of my limited travels I have experienced the truth of this observation; for, after having spent many days in endeavouring to determine

† Neues Bergmannisches Journal. B. i. § 272.

mine the relative position of certain strata to each other, I have been obliged to rest satisfied with a general conclusion drawn from the nature of the surrounding rocks. Thus, in Glencloy, I could not discover the porphyry and sandstone at their junction; yet, if we consider that the porphyry, both here and at Corygills, is found upon the summit of sandstone hills, and that, in this place, we observe the same basaltic vein apparently traversing the sandstone and porphyry, we may presume that they are of the same formation, and that the porphyry covers the sandstone. We have more certainty with regard to the sienite, which appears to be of an origin anterior to the sandstone; as is pretty well shewn from the appearance of a breccia that lies upon its surface, which had been interposed between it and the sandstone, before the causes which formed the glen had removed the sandstone.

GLENSHIRREG. This glen is of considerable extent, bounded upon one hand by Glencloy, and on the other by Glenrofa. The hills towards the W. are not so rugged as those at the top of Glencloy, and both the bottom and sides are formed of the common sandstone, much traversed with veins of basalt; but towards the S. W. we observe a clay-porphry, which forms part of the rocks higher up than the sandstone, and is, in fact, part of the mass we observed before in Glencloy.

GOATFIELD.

GOATFIELD. This mountain, according to Professor Playfair, is about 2945 feet above the level of the sea, and is reckoned the highest in the island. It rises pretty rapidly from the south side of Brodick Bay, until we arrive at the region where the micaceous schistus disappears. At this height there is a kind of irregular plain, from which the mountain rises in the form of an obtuse pyramid, and is very precipitous, being entirely formed of granite. On the W. where it forms part of Glen-rofa, it is extremely steep, which is owing in a great measure to the want of micaceous schistus and sandstone; for, in general, wherever these occur the declivity is less sudden. On the east side the pente is more gradual; marking, according to the steepness, the presence of granite, micaceous schistus, or sandstone. It declines a little towards the N. but it rises again, forming one of the boundaries of the rude Glen-Sanicks: it also forms the top of the bare, rugged and sterile Cory-Glen, and the top of the other two great hollows between the Cory-Glen and Glen-Sanicks.

The lower part of Goatfield is composed of the usual red-coloured sandstone, and is traversed by veins of basalt; this continues for several hundred feet up the mountain, when it at last disappears: the micaceous schistus rises from under it, separated only by a stratum of breccia, thus shewing the relative position

position of the sandstone and micaceous schistus. The micaceous schistus continues until we arrive at the plain formerly mentioned; but the side of the mountain, in some places, is so covered with the debris of granite, micaceous schistus, &c. that it is only by the appearance of the granite, in the neighbourhood of this plain, that we are aware of its existence, as the ascent is hardly more steep over the micaceous schistus than the sandstone, which is not generally the case; for we find, when the strata are not covered with debris, that the sandstone is far less steep than the micaceous schistus, and this last than granite. Even in this way, we have a kind of general rule for judging of the nature of mountainous ridges. If they be peaked, and very precipitous, we may presume that they are of granite; if they be less lofty, and not peaked, but still somewhat approaching to the conical shape, we may suppose them to be composed of micaceous schistus; and, lastly, if we observe these skirted by lower mountains, with a trifling pente, we may conclude that they are composed of sandstone and limestone. Although these observations may hold true in general, yet they will sometimes be found liable to considerable variations: thus we know that the shape, and other appearances, of mountains composed of similar rocks, are apt to be varied by several circumstances, particularly by the horizontality or verticality of the strata, their degree of compactness, and their aptness

aptness to be weathered. It would be an addition of some consequence, if we had a few general rules on this subject. Saussure well remarks, " Les signes qui peuvent donner quelque indice de la nature des montagnes, à de grandes distances, et au travers des plantes qui les couvrent, sont en petit nombre, et méritent d'être étudiés et consacrés par des termes propres."

The pyramidal part of the mountain has a very sterile and wild aspect; being completely covered with loose blocks of granite, and destitute of all vegetation, excepting a few lichens, which only add to its bleak appearance. These blocks differ very much in size, some being twenty feet long*, and generally of a quadrangular shape; and are so heaped upon each other, as to render the ascent very difficult. Having, however, gained the summit, we are well repaid for our labour by a most extensive view of a wonderful diversity of country. To the
E northward

* Dr. Walker has observed immense solid masses of granite in different parts of the Highlands: but these are vastly inferior to others that have been found in other countries. About thirty miles from the Cape of Good Hope there is a large mass of granite, called the Pearl Diamond, which is about half a mile in circumference, and 400 feet high. *Phil. Trans.* 1778, p. 102.

northward we look down upon the peaked summits and deep glens in the neighbourhood of Goatfield, whose arid and reddish appearance suggests to our minds the effects of a dreadful conflagration. Beyond these, the isthmus of Cantyre, the island of Isla, the lofty and dreary paps of Jura, the long mountainous ridges of Argyleshire, and the far-distant mountains of Mull, which are faintly descried, present a view rather to be felt than described. On the E. the well cultivated island of Bute, the frith of Clyde, the Cumbray Islands, backed with the beautiful coasts of Renfrewshire, form a most picturesque scene. Towards the S. we have, below us, the lower part of the island spread out like a map, forming a singular appearance of heath-covered mountains and cultivated glens: farther distant, the charming coasts of Ayrshire, the shores and mountains of Galloway, as far as the Mull, the stupendous craig of Ailsa, rising from the bosom of the ocean, all delight the eye and ravish the imagination. Lastly, on the W. the coast of Ireland, from Fairhead to Belfast Loch, concludes the amazing view from this interesting height.

GLENROSA. This very striking glen, situated upon the west and south-west sides of Goatfield, is about five miles long, and half a mile broad, bounded by very high mountains. The
bottom

bottom forms a considerable angle with the sides, rising gradually towards the upper, or north end, where it is formed partly by the mountain called Keid-voe, and partly by Goatfield. The mountains on the opposite sides of the glen are of different heights, (being far higher on the east than west;) but the inclination of the opposite slopes is the same, being about 70° . At its entrance upon the shore at Brodick Bay, it has Goatfield on the north, and Glenfhirreg on the south. On the south side, the strata are common argillaceous sandstone, traversed by basaltic veins; but this continues only for a short way, as the micaceous schistus soon makes its appearance. Upon the north side, a very little sandstone is to be observed at the bottom of the hill, the upper part being formed of micaceous schistus. Amongst the debris of the micaceous schistus I observed great blocks of a rock, which is principally composed of hornblende, and now and then intermixed with quartz, and a substance that appears to be the same with the paliopetre of Saussure. The micaceous rocks upon both sides of the glen lie upon granite, which soon presents itself as we proceed up the glen, and forms the mountains upon both sides to its further extremity. This granite, which is similar to that of Goatfield, appears to be dispersed in great strata, that run N. and S. which is nearly in the direction of the glen. If we view them from

the bottom of the glen, they appear like great perpendicular walls, which are split in many places into rhomboidal masses; but if we clamber upwards for some hundred feet, we at length discover the edges of the strata, extending for a great way, and emerging here and there from above the loose blocks of granite, which have fallen from the mountains, or have been formed by the splitting of the banks themselves.

It was long believed, by geologists, that granite never occurred in strata, but merely formed great massive mountains. This has been shown to be erroneous by many later observers; yet La Metherie, in the last edition of his *Théorie de la Terre*, speaking of granite mountains, remarks, “ Les masses ne sont
 “ ni par bancs, ni par couches, comme l’ont prétendu de fa-
 “ vans naturalistes. J’ai parcouru une grande quantité de ter-
 “ reins primitifs, et je n’y ai jamais vu de couches. Quelque-
 “ fois on apperçoit des masses assez considérables de granites,
 “ ayant une figure presque rhomboïdale, superposés les uns
 “ sur les autres. Mais on ne fauroit regarder ces superposi-
 “ tions pour des couches, puisqu’elles n’ont rien de régulier,
 “ et que ces masses, presque rhomboïdales, ne se rencontrent
 “ que très rarement. Le plus souvent ces granites sont fen-
 “ dues, en différens sens. Ces fissures se correspondent
 “ quelque-

“ quelquefois ; ce qu'on prendroit, au premier coup-d'œil,
 “ pour des espèces de couches ; mais un examèn plus appro-
 “ fondi en fait bientôt reconnoître la difference †.” To these
 observations we will oppose that of several geologists who have
 observed strata of granite, similar, I imagine, to those which
 occur in Arran, in different parts of Europe. The late cele-
 brated M. Sauffure, whose accuracy of observation is not to
 be questioned, discovered granite dispersed in strata in many
 parts of Europe ; as may be seen by consulting his most inte-
 resting and elegant volumes. Reuss, in his mineralogical geo-
 graphy of Bohemia, has detailed minutely many similar ap-
 pearances ; and my learned friend Dr. Mitchell informs me,
 that the Reisenbergs, a chain of mountains which separate Si-
 lesia from Bohemia, are composed of granite, for above fifty
 miles, and in this long course it is invariably disposed in strata
 nearly horizontal ‡.

Upon the east side of the glen several curious appearances are
 to be observed. Of these, the most interesting are the basaltic
 veins,

† Tom. iv. p. 352.

‡ Mr. Kirwan, in his Geological Essays, refers to several other authors who
 describe granite disposed in strata.

veins, which traverse the granitical strata, as they do the porphyry and sandstone*. The first vein which I discovered, being between three and four feet in diameter, is to be observed rising through the granite, several hundred feet above the bottom of the glen. Its lower part is hid by the heather, and loose blocks of granite, which cover the sides of the mountains. As it rises upwards it becomes gradually narrower, and at last divides into two branches, which run through the granite, contracting and enlarging their diameter from a few inches to more than two feet. The extremity of one of these branches appears either to have been broken, or so sunk inwards as to cause one part of the branch to appear separated from the other, as is represented in the plate; where A is the granite, B the basalt vein, C the branch having the appearance of being separated from D by intervening granite †. In the body of the great vein

* However commonly we observe basaltic veins traversing the granite in this island, yet it appears to be a rare occurrence in other countries. Reufs never observed it in Bohemia; and Sauffure, in a late communication to the *Bibliothèque Britannique*, assures us that he never observed any basaltic rock among granite. *Bibl. Brit.* vol. vii.

† Rocks which are disposed in strata present similar appearances with the vein above described, and of this we have a curious example in Salisbury Craigs near Edinburgh. This hill, which is entirely composed of rocks of trap formation,

vein there is immerfed a confiderable wedge-shaped piece of granite, marked in the plate at E; which has the ufual hardnefs, colour, &c. of that fpecies of which Goatfield is formed. The granite and bafalt are not intermixed at their junction; no matter is interpoſed; and they are not altered in the leaſt by being in contact with each other. In the neighbourhood of this vein were found ſpecimens of rock cryſtal in cavities of the granite; and ſome of the cryſtals were of confiderable ſize, but generally of a ſmoke colour. I alſo picked up a ſpecies of granite ſimilar to the pierre graphie which is found at Portſoy*; alſo a ſtone much reſem-
tion, affords ſome fine views of its ſtratification, in a lofty cliff that extends around a confiderable part of it. Towards the north extremity of this cliff, the red-coloured ſandſtone, which lies below the baſaltic rock, is much waved in its courſe, and, at one place, a part of the ſandſtone ſtratum appears detached and immerfed in the baſaltic rock. The incloſed piece of ſandſtone is of great ſize, ſtill preſerves its ſtratified-like aſpect, only it is very hard. Dr. Hutton reckons it a ſtrong proof of the truth of his theory: but Mr. Deriabin, an intelligent mineralogift, who examined it along with me ſome time ago, thinks, that the ſtratum is not broken, only that it ſinks behind the baſalt, as I have conjectured may be the caſe with the vein above deſcribed. Dr. Hope informs me that ſeveral ſimilar appearances are to be obſerved in the neighbourhood of Edinburgh.

* I found a ſimilar rock among ſome foſſils ſent me from Hudſon's Bay; and, by a late memoir of Patrin in the Bibliotheque Britannique, (vol. 8. p. 78.) it proved alſo to be a production of Corſica.

resembling the veined granite of M. Sauffure; and likewise a curious species of granite, where the quartz, felspar and mica were distributed in a radiated form, as is the case with many zeolites.

Near to the summit of Goatfield I picked up several pieces of rock, which is evidently the same with the paliopetre of Sauffure, which he found loose near to the summit of Mont Blanc in Switzerland †. Lower down, but upon the same side of the glen, many fragments of basalt are to be observed, lying upon the sides of the mountains, showing the presence of basalt veins; and at the Keid-voe a great vein is to be seen, rising perpendicularly through the granite. Nearly at the same place, I was much surprised to find several columns of dark leek-green coloured pitchstone lying amongst the debris of the granite; but, after considerable labour, I was not able to discover its situation.

Not far distant from this, in ascending towards the summit of Goatfield, amongst the loose blocks of granite which cover its sides, I observed a curious appearance. Upon
breaking

† Voyages dans les Alpes, tom. 7me, p. 275.

breaking these rocks, with an expectation of discovering rock crystal, I found in several of them masses of compact granite, of different sizes, either rounded or angular. Somewhat similar appearances have been observed by other mineralogists: thus Mr. Werner has in his possession a mass of granite which contains pieces (geschiebe) of gneiss*; Mr. Roster found between Ellbogen and Schlackenwalde, in Bohemia, a great-grained granite†; and Mr. Sauffure observed a mass of granite which contained an oval piece of gneiss‡. Mr. Werner reckons his specimen a proof that the gneiss is of earlier formation than the granite; in other words, that the pieces of gneiss have been broken off a stratum which was deposited before the granite. Mr. Sauffure, however, is of an opposite opinion: he is inclined to believe that these pieces of granite or gneiss have been formed simultaneously; and that they have, by some peculiar circumstance, affected a rounded form, which is not manifested in the other parts of the rock. This conjecture is rendered more probable from the following fact: “I have often seen, says he, in veined granite, rounded pieces of a far
F “finer

* Werner, Kurze Klassifikation der verschiedenen Gebirgsarten.

† Emmeiling Lehrbuch der Mineralogie. B. 3.

‡ Voyages dans les Alpes.

“ finer grain, which nevertheless had been formed simultane-
 “ ously, since we observed the continuity of the layers of the
 “ fine-grained, with that of the granite in great grain and
 “ thick layers.”

The west side of the glen is formed in part by a granitical mountain, named Ben-echleven, which presents to us the great flat sides of the granitical strata. Its top is covered with enormous blocks of granite, which rest upon it in a most fantastical manner. This mountain declines rapidly towards the N. E. forming a tremendous hollow, named Cory-dain, whose bottom is far elevated above that of Glenrosa, but is lower than the bottom of the next hollow, named the Feun-hody, which is raised far above either, presenting to the bewilder'd eye an amazing scene of ridged and peaked rocks of granite. In the Cory-dain, the granite, at first sight, appears to be stratified horizontally; but an examination shews us that is owing to the splitting of the granite. Here also we observe the granite disintegrating in the form of sand, and, what is more rare, decomposing in the manner of some species of basalt, that is, in crusts *. Sauffure, speaking of this kind of decomposition, remarks :

* Granite decomposes in concentric layers.—Charpentier Mineralogische Geographie der Churfürstlichen Lande. § 31.

marks : “ Un autre fait, dont je trouvai la solution en exami-
“ nant ces granites de près et avec attention, c’est celui de ces
“ exfoliations que j’avois observées dans la vallée supérieure.
“ C’est un fait connu de tous les minéralogistes, que la plupart
“ des pierres sont plus tendres dans le sein des montagnes qu’à
“ leur extérieur, et qu’elles acquièrent à l’air un degré de
“ dureté sensible. Il suit de-là, que la partie extérieure, ou le
“ bord de la tranche verticale d’une grande assise de granite,
“ doit se durcir par le contact de l’air, tandis que l’intérieur
“ de la même assise conserve un certain degré de mollesse. Et
“ tant que les assises inférieures demeurent un peu molles, le
“ poids énorme de toutes celles qui reposent sur elles doit à la
“ longue les comprimer. Mais les parties extérieures, durcies
“ par le contact de l’air, ne sont pas susceptibles de la même
“ compression. Elles doivent donc s’en séparer, et former ainsi
“ les exfoliations que l’on observe *.”

F 2

A R R A N.

* Voyages dans les Alpes, tom. 6me, p. 318.

A R R A N.

C H A P. IV.

Description of the FOSSILS mentioned in the preceding Chapter.

PITCHSTONE.

ARGILLA PICEA, Werner. *RETINITE*, La Metherie. *OPALUS*,
PICEUS, Gmelin.

PITCHSTONE from Lamlaß Road.

Colour. Dark leek-green.

Lustre. Internally it is glancing *, with a waxy lustre †; is often beautifully iridescent, and this is particularly the case at the thin edges of the splinters.

Hardness. Gives a few feeble sparks with steel, but is very brittle.

Fracture.

* Glänzend.

† Wachsglanz.

Fraçture. More or less perfectly multiplied conchoidal, or splintery; often shistose; and rarely presents distinct concretions.

Fragments. Almost always in the form of four-sided irregular columns.

Transparency. Transmits a very little light at the edges.

Fusibility. At 23° of Wedgewood's scale, it becomes black, is much rent, and internally a little porous; at 55° it had formed a porous enamel; and at 70° it became perfectly white, and the enamel was little porous.

It frequently contains a few crystals of white felspar, which appear of the nature of adularia; and I observe interspersed grains, apparently of quartz. This species is often intermixed with one similar to that observed at Brodick wood.

PITCHSTONE—Brodick Wood.

Colour. Dark leek-green; but the number of distinct concretions often give it a lighter hue.

Lustre. Little glancing*, with a greasy lustre †.

Transparency. Transmits a very little light at the edges.

Hardness.

* Wenig glänzend.

† Fett glanze.

Hardness. Gives a few sparks with steel.

Fracture. Uneven, conchoidal, and sometimes splintery, with numerous distinct concretions; in the gross is often flaty.

It sometimes contains crystals of white felspar and quartz, crystallised in six-sided pyramids.

It decomposes, by the action of the weather, in the form of a white tegmen, which is often separable into layers; and, by the decomposition of the felspar, it gets a cellular appearance, when it requires an experienced eye to distinguish it from some of the productions of Lipari. It is also frequently traversed with another species, which has a greater degree of lustre, and is more difficultly decomposable by the action of the weather; so that specimens of this kind, when decomposing, present a striped surface of dark-green and white, the dark-green being the undecomposed species. Gerhard, in his Mineral System, mentions a species of gneiss, or granite, that contains obsidian, a stone much allied to pitchstone. Dr. Townson, in his Travels through Hungary, remarks, that this gneiss is a species of obsidian, with black and white layers, containing also, probably, a few crystals of adularia and scales of mica. The stone I have now described appears to be of the same kind, and this is rendered more probable from its sometimes containing felspar.

BROWNISH-

BROWNISH-BLACK PITCHSTONE—*South Side of Glencloy.*

Colour. Brownish-black.

Lustre. Little glancing, with waxy lustre.

Transparency. None.

Hardness. Gives a few sparks with steel.

Fracture. Uneven, with a tendency to the conchoidal.

Fusibility. At 21° it intumesced a little; its colour was slightly altered; the surface glazed, and, internally, porous. At 31° , intumesced considerably, and softened. It had then, externally, a brownish glazed covering; internally, colour is grey, and very porous. At 65° it had intumesced very much; forming an externally cavernous, yellowish-brown coloured mass. At 100° it became more compact.

There are generally a few crystals of white felspar dispersed through it; and it acquires, by the action of the weather, a slight brown tegmen.

BLACK PITCHSTONE.

Colour. Black.

Lustre. Little glancing, with a waxy lustre.

Transparency.

Transparency. None.

Hardness. Gives a few sparks with steel.

Fracture. Straight, flaty; and the slates appear to be formed by the superposition of small foliæ. The plates are also sometimes covered by a metallic yellow-coloured illinition.

Smell. When powdered, it emits a bituminous smell; which renders it probable it may contain inflammable matter*.

It has generally a few crystals of white felspar dispersed, and these by decomposition acquire a brown colour: sometimes we also observe a yellow-coloured, nearly transparent substance accompanying the felspar.

These different kinds of black pitchstone appear to pass into basalt. A curious specimen of this kind occurred to me in the neighbourhood of Kilmichael-House, in Glencloy. One part is common black pitchstone, but it gradually loses its lustre; its fracture passes from the conchoidal to the plain splintery; then it gives a grey streak, is not at all fragile, in short, is a fair basalt.

O B S E R -

* Mr. Kirwan has found several pitchstones to contain inflammable matter.

Kirwan's Mineralogy.

OBSERVATIONS.

When pitchstone was first discovered, it was believed by mineralogists to be the lapis obsidianus of Pliny*: its resinous or pitchy colour, however, sufficiently distinguished it from the true obsidian, which was afterwards found in Hungary, Iceland, the South-Sea Islands †, &c. It was first discovered in Saxony; but it has not till now been described as a British fossil.

From its great resemblance to certain volcanic productions, it has occasioned a considerable warfare between the Neptunian and volcanic philosophers. The volcanists rest their opinion on the following facts. 1. Pitchstone has been observed to pass into obsidian; a stone which is found in the neighbourhood of Mount Hecla in Iceland, and hence reckoned volcanic. 2. Pearlstone, which seems only a species of pitchstone, is

G

found

* Baron Veltheim has endeavoured to shew that the obsidian of Pliny corresponds to several other stones.

† Neues Bergmannisches Journal. B. i. § 94.—The whole of the Isle of Ascension, according to Foster, is composed of obsidian.

found not only to inclose balls of obsidian, but even to pass, on the one hand, to obsidian, and, on the other, to real pumice*. Mr. Camara, who had examined the pitchstone of Hungary, was convinced, from its alternation with rocks decidedly Neptunian, that it could not claim a volcanic origin; and he rendered his proof more complete, when he demonstrated, that the obsidian was converted into a porous spongy mass by the blow-pipe, intimating that it had never been exposed to the action of volcanic fire†. More lately, Lampadius, professor of chemistry at Freyberg, has found, that the pitchstone is affected by fire in the same way as the obsidian‡; and has completely overthrown the volcanists, by the discovery, that the true obsidian contains 2 lb. 5 oz. of water per cent. ||

As the pitchstone which occurs in Arran is convertible into a porous or fibrous mass by the action of the fire, and forms veins

* Esmark N. Bergmannisches Journal. Vol. 2.

† Bergmannisches Journal, 1794. B. 2. § 245.

‡ Neues Bergmannisches Journal. B. 1. § 84.

|| A whole pound weight of obsidian was distilled in a porcelain retort, and afforded 145 grains of pure water.

veins in sandstone, a volcanic formation cannot be attributed to it.

Fusibility of Pitchstone. Pitchstone has been found by mineralogists to possess so very different degrees of fusibility, that it leads me to enquire if they have all employed the true pitchstone in their experiments. Mr. Morveau Guyton found the pitchstone of Menil mountain, near Paris, to remain unaffected at a very high degree of Wedgwood's scale *. Mr. Kirwan, who has made many experiments on their fusibility, found that the most fusible formed an enamel at 130° of Wedgwood; but in general were far more refractory, some remaining unchanged at 160° †. It is plain that these fossils are quite distinct from the pitchstone of Arran: indeed, were they proved to be the pitchstone of Werner, I would not hesitate to arrange the Arran stones as a new and distinct genus. It is now known, however, that several stones, which formerly passed for pitchstone, belong to the semiopal. Dr. Mitchell informs me that the infusible pitchstones of Hungary are semiopals; and Dolomieu remarks, that the pitchstones of the island of

G 2

Elbe,

* Journal Polytechnic.

† Elements of Mineralogy. Vol. 1. p. 293, 294.

Elbe, Piedmont, and the wood which is converted into yellow and white pitchstone from Hungary, are all very difficultly fusible, and he therefore reckons them refiniform chalcedonies †, (or, more properly, semi and wood opal.) It is not then improbable that the pitchstones, which Mr. Kirwan and Morveau Guyton examined, were semiopals, or stones nearly allied to it.

The real pitchstone, according to Emmerling, is easily fusible ‡; Dolomieu found the pitchstones of the Isles Ponces and of the Paduan mountains easily fusible; and, lastly, Messrs. Camara, Deriabin and Lampadius observed a similar fusibility. These facts agree with my trials on the Arran pitchstone, and entitle me to reckon it the pitchstone of Werner.

BASALT.

BASALTES, Marmor. Agric. *BORAX BASALTES*, Lin. *BASALTES COLUMNARIS*, Waller. *ARGILLA BASALTE*, Werner. *COMMON TRAP*, Kirwan.

BASALT—

† Journal de Physique. Vol. 40. p. 215.

‡ Lehrbuch der Mineralogie. B. 1. § 264.

BASALT—*South Side of Glencloy.*

Colour. Black.

Lustre. A number of shining particles dispersed through it, which is probably hornblende*.

Transparency. None.

Hardness. Scarcely gives fire with steel.

Fracture. Even earthy, but is very compact.

By decomposition acquires a brownish-coloured tegmen.

BASALT, *which forms a vein running in the porphyry—*

Head of Glencloy.

Colour. Lavender blue, intermixed with yellowish green; by decomposition, red.

Lustre. None.

Transparency. None.

Hardness. Yields pretty easily to the knife.

Fracture.

* Hornblende having been found to contain charcoal, or probably carbone, as a constituent part, has been ingeniously mentioned by Dr. Walker, as one fact, to shew the transition from plumbago to hornblende, which he imagines he has observed in several other instances.

Fracture. Rather uneven fine splintery.

Fusibility. Melted at 103° .

BASALT, which forms veins traversing the granite—

East Side of Glenrosa.

Colour. Greyish, or black.

Lustre. A number of crystals of hornblende, dispersed through it, give it a slight degree of lustre.

Transparency. None.

Hardness. Gives a few sparks with steel.

Fracture. Uneven earthy.

Gives a grey trace.

Fusibility. Melted at 58° . This fusibility distinguishes it from the species of basalt examined by Mr. Kirwan. He found them fusible from 120° to 130° ; and the figurate trap, or columnar trap, melted at 100° .

It contains yellow-coloured olivin, and in greater quantity than I have observed in other species.

In the former edition of this work, I conjectured that both the pitchstone and basalt might contain potash. Since that period, Dr. Kennedy has analysed basalt, wacken-porphry and greenstone, and these he finds to contain a small portion of

soda

soda and muriatic acid ‡. Dr. Mitchell, to whom I communicated Dr. Kennedy's experiments, has lately repeated them upon the famous basalt of Stolpen, but obtained a very different result. Having detected a small portion of muriatic acid, he then powdered a quantity of the stone, and mixed it with sulphuric acid; then distilled to dryness, and lixiviated the solution: the solution was decomposed by the acetite of lead; the supernatant liquor was then evaporated to dryness, and the acetic acid burned off. The residue, which was pure alkali, afforded, with nitrous acid, prismatic nitre: a decisive proof of potash.

SIENITE.

SIENITES, Marmor. *Pyropoecilus*, Plin. et Al. *SRENITES*, Dr. Walker's Class. Fossil. *GRANITES SIENITES*, Gmelin. Syft. Nat.

This rock we have remarked forming strata at the head of Glencloy, and it occurs in many other parts of the island: I shall now mention its external characters. To prevent repetition, I will shortly detail the different species, placing the ingredients in their order of proportion.

1. Felspar;

* Transactions of the Royal Society of Edinburgh, vol. 5th.

1. Felspar; reddish.

Hornblende; green, and sometimes black.

Quartz; white, and sometimes brown.

This species is more or less compact, and is sometimes shistose.

2. Hornblende; green.

Quartz.

Felspar.

This aggregate, which is almost entirely composed of hornblende, has the following characters:—

Colour. Dark leek-green.

Lustre. A number of shining points dispersed through the mass, owing to the hornblende.

Transparency. None.

Hardness. Gives fire with steel, but not very plentifully.

—Leaves a grey trace. It is difficultly distinguishable from many species of basalt, and is often intermixed with patches of the first species.

3. Quartz.

Felspar.

Hornblende.

This species, owing to the great proportion of quartz, has much the appearance of a sandstone.

4. Horn-

4. Hornblende.

Quartz.

Felspar; greenish-coloured.

The hornblende, in this compound, has sometimes a metallic lustre, approaching to the nature of schiller spar; and the felspar is tinged green, owing to the diffused matter of the hornblende.

OBSERVATIONS.

The different species of sienite were long confounded with basaltic and granitic rocks: a circumstance which was owing, not only to the want of an appropriate name, but to the difficulty of distinguishing the gradations. Werner first named it greenstone; but he now calls it Sienite, from a conviction that it was a similar stone which Pliny described as being found at Sienna in Upper Egypt. In antient times it was quarried in great quantities at Sienna; and from thence was brought to Rome for the building of great public edifices, and for the use of the statuaries, who worked it into pyramids, obelisks, &c. The famous Sarcophagus of Cheops, and Pompey's Pillar at Alexandria, are now known to be of sienite.

As the discovery of metallic veins is one of the great objects of mineralogy, we think it not out of place to introduce, among the general observations we may have occasion to make during the course of the work, a short account of the different veins of ore which have been observed traversing similar rocks in other countries. In pursuance of this plan, we may remark, that sienite, in some places, is rich in metals: thus, at Scharffenberg there are veins of silver and lead, and part of the productive Altenberg mine-works are in sienite: we believe that the veins of Strontian in Argyleshire run in a similar rock.

CLAY PORPHYRY—*Cory-Gills.*

THON PORPHYRY, German.

Colour. Brownish basis; by decomposition, acquires a white tegmen.

Lustre. None.

Transparency. None.

Hardness. Is difficultly scraped with a knife.

Fracture. Splintery.

Smell. Strong earthy smell, when breathed on.

FELSPAR

FELSPAR—Is of a brownish colour; sometimes white and crystallized.

QUARTZ—Is of various colours, white, yellow, or smoke; of different shapes, angular, rounded, or regularly crystallized, presenting often six-sided pyramids, which is a rare appearance in porphyry: it is also sometimes dispersed through the basis in the form of strings.

PORPHYRY—*Glencloy.*

The basis of this porphyry differs, in general, but little from that of Corygills: in particular instances, however, we observe it nearly in the state of hornstone, and having the following characters:

Colour. Grey.

Lustre. None.

Transparency. A very slight degree at the edges.

Hardness. Gives a few sparks with steel.

Fracture. Even.

Smell. A strong smell, when breathed on.

The crystals of felspar are much larger than in the clay-porphry; and, besides, I observed it to contain a softish substance, probably steatitical.

GENERAL OBSERVATIONS.—

The true porphyry was long confined by mineralogists to a particular stone which was supposed to have a jaspideous basis; but Werner has extended its signification much farther, and now reckons eight different kinds. It would be useful here to follow the Linnæan mode, by dividing them into distinct genera; and then the species might be described in short characters, as has been done in botany. This will probably be reckoned useless labour by those who think that fossils are not capable of such arrangement: we are well convinced, however, that, in the present instance, as well as in many other parts of mineralogy, much good may be done by such attempts.

In modern times, porphyry has been principally used for ornamental purposes; and, where compact, it has been found to answer well for millstones. The Greeks and Romans used it for the construction of their finest edifices; and the statuary often cut it into busts, vases, &c. of the most exquisite workmanship.

The

The porphyry in this island, so far as my experience goes, does not afford any veins of ore; yet in other countries it is sometimes productive. Thus, in different parts of Germany, a species, similar to what we observe in this island, has been found to contain veins of tinstone, iron ore, manganese, galena, and molybdana.

SILICEOUS SHISTUS.

GEMEINER KIESELSCHIEFER, Wern. *HORNFLINT*.

Among the debris which covers the bottom of Glencloy, I discovered specimens of a rock which seems to be siliceous shistus; but I could not discover it *in situ*. It presents the following characters:

Colour. Grey, or greyish black.

Lustre. None.

Transparency. Transmits extremely little light at the edges.

Hardness. Gives fire plentifully with steel.

Fracture. In the gross, flaty; of the single plates, more or less fine splintery, inclining to the even.

It has dispersed through it grains of quartz, and very minute

nute particles of a softer substance, whose nature I could not determine.

GRANITE.

GRANITES GENUINUS, Lin. *GRANITES DURUS*, Cronsted. *SAXUM*
quartzo, spato scintillante et mica in diversa proportione mixtis,
compositum; Waller, Syft. Miner. vol. i. p. 407.

The granite of this island is, in general, pretty compact; of a whitish-brown colour, owing to the slight-brown tinge of the felspar. To describe all the varieties that occur might be useful; but that is more adapted for a systematic treatise of mineralogy than an outline of this kind. I shall only, therefore, give a particular account of two species; the Great-grained, or Common Species, and the Small-grained.

I. GREAT-GRAINED GRANITE.

This species is not only remarkable by its forming a very considerable part of the solid materials of the island, but also on account of the peculiarity of its composition; as it frequently contains three species of felspar, and the quartz is often crystallized.

1st Species, FELSPAR—Is of a white colour, with a slight tendency to the brown; having the usual lustre, transparency, and hardness.

2d Species, ADULARIA?

Colour. White.

Form. Either in amorphous masses, or crystallized in hexahedral prisms, bevelled at both ends.

Lustre. External, like that of crystals not much polished; internal, same.

Transparency. Sometimes objects can be seen pretty distinctly through the crystals; but when they are a little decomposed, opacity is produced.

Fracture. Plain foliated, and sometimes striated.

Hardness. Gives fire plentifully with steel.

Fusibility. At 100° the surface was formed into a yellow-coloured enamel.

3d Species—Is of a white colour, having nearly the usual hardness, fracture, &c. of the common felspar; differing principally in the lustre, which is like that of polished metals, reflecting, in certain directions, a silver light.

QUARTZ—

QUARTZ—Is frequently colourless; also greyish, pale yellow, pale, or dark brown, and sometimes nearly black, when it is called Morion.

Is very often crystallized; and either in the form of hexangular prisms, terminated by hexangular pyramids at one or both ends, and the prisms are feamed across. The crystals are sometimes found several inches long, and from two to three inches diameter; of a pale brown, or rather smoke colour. These last are much valued by the lapidaries.

MICA—Is often black; sometimes golden yellow, tombac brown, or green. It is generally in the form of irregular plates; and pretty frequently hexagonal plates occur, which, being superimposed upon each other, form a hexagonal figure of some magnitude. It is the mica lamellense hexagone of Rome d'Isle, (vol. ii. p. 509.) and the hexagonal mica of the Abbé Huay, (Miner. vol. v. p. 296.)

The constituent parts of the granite are very various in their proportion; but, in general, the felfpar forms the most considerable part, then the quartz, and lastly the mica.

II. SMALL-GRAINED GRANITE

Is very compact, with an uneven fracture; composed of felspar and quartz, in nearly equal proportions, with very few scales of black mica. It is subject to much variety; not only on account of the size of the particles, but also from their relative proportion, their degree of compactness, &c. Some varieties are so compact, and have such a general appearance, as easily to pass for sandstone: but a careful examination of the figure of the particles, the want of substramen or basis, and, lastly, its situation in the earth, afford sufficiently distinct marks of difference. It is generally found in fissures, which traverse the great-grained granite in all directions; but it also occurs in patches dispersed through it*.

BRECCIA.

I have already remarked that the common breccia, which runs among the sandstone, is formed of fragments of sand-
I stone

* It has been observed in the mountains of the Hartz, that granite affects the magnetic needle; but it is said only in mass, and in a perpendicular vein. Mr. Deriabin, however, informs me, that this is not quite correct; for he has observed it to act in detached pieces.

stone and quartz, immersed in an arenaceous basis. Another species occurs upon the summit of the sienite hills, back from Glencloy. It has an arenaceous basis, approaching, in appearance, to basalt; and containing rounded or angular masses of granite similar to that which forms Goatfield, micaceous schistus, quartz, porphyry like that of Glencloy, basalt, and palio-petre. I was not able to discover its real situation; but its composition shewed that it was probably interposed between the primary and secondary strata. The circumstance of its containing granite, explained a phenomenon which long puzzled me—the appearance of rounded masses of granite upon the summit of several high hills; these evidently owing their origin to the decomposing breccia.

A R R A N.

BRECCIA

I have already remarked that the common breccia, which runs among the sandstone, is formed of fragments of sandstone. It has been observed in the mountains of the Harz, that granite affects the magnetic needle; but it is said only in mass, and in a perpendicular vein. Detachin, however, informs me, that this is not quite correct; for he has observed it to act in detached pieces.

A R R A N.

CHAP. V.

Cory; Cock of Arran; and Loch-Ranza.

HAVING now given a pretty extended description of the strata and fossils in the neighbourhood of Brodick Bay; I shall, in the next place, proceed to trace the strata round to Loch-Ranza, which is situated upon the north-west side of the island.

From Brodick Bay, the cliffs all around are low, and, for a great way, composed of the usual red sandstone, which is much traversed by veins of basalt, of various widths, and running in different directions. Coves occur in several places, but none are of considerable size: frequently calcareous stalactites hang from their roofs. The action of the sea upon the sandstone has given a singular aspect to the whole shore; owing

to soft sandstone being washed away, while the more compact and hard, which appears to have been formed in fissures, is left standing in long ridges, or cristæ. The sandstone, as it rises upwards, forms part of the lower region of Goatfield, in the vicinity of the micaceous shistus, which it, in all probability, covers. About a mile from the Cory, nearly one hundred feet above the level of the sea, there is a stratum of limestone, about twelve feet thick, running at an angle of 20° , and covered with red-coloured argillaceous sandstone; but, below, interposed between the limestone and sandstone, there is a layer of a red shistose clay. In this clay I observed regular series of shells, deposited in layers, (all appearing of the same species,) with their convex sides regularly downwards. The stratum is sometimes straight, but often waved and twisted. It also frequently contains radiated calcareous crystals, which are of a reddish colour, owing to the admixture of iron. In a fissure of the sandstone, above the limestone, I observed stalactites of peat, of considerable size and consistence, which appear to have been formed by the infiltration of the soluble peat-matter through the sandstone. To the N. of this stratum there is a considerable ravine, which luckily afforded me an opportunity of observing the junction of the different strata. Here I traced the common red-coloured argillaceous sandstone from the shore to a considerable height, and, in some places, observed

served it intermixed with fragments of quartz; thus forming a kind of breccia. As we approach the primitive rocks, the sandstone strata become more elevated; and, at length, I observed it lying on a compact shistose rock, which appeared to be of the nature of micaceous shistus; but it was so much decomposed by the action of the weather, that I could not well determine exactly as to its particular designation. This micaceous shistus? continues but for a short way, when it is to be seen lying on the granite, which rises upwards, forming a very steep ascent, which leads to the rugged and sterile-looking Coryglen. This glen is very precipitous on all sides; is broader than any in the Goatfield groupe, but is comparatively shorter: its bottom is higher than that of Glenrofa, but not so much elevated as that of the Cory-dain or Feun-hody. It is entirely composed of granite; which is here split, as usual, into immense blocks, that are piled in vast tumuli upon the tops of the surrounding mountains, or cover the sides and bottom of the glen, as with ruin and desolation.

Having returned again to the sea-shore, I continued my journey; and, as I approached the Cory, observed a vein of soft, red, shistose sandstone, containing rounded pieces of argil running through the sandstone N. E. and S. W. At the Cory, where there are a few houses, I observed quarries of
sandstone,

sandstone, of a beautiful white colour, and of good consistence for building. These quarries are now worked, by a company, for the construction of the Crinan Canal. Here there is also a stratum of limestone, about thirty feet thick, considerably inclined to the horizon, running N. N. W. and divided into strata, as the stratum formerly mentioned, with intervening clay and shells, but the clay is more or less indurated. From this towards West Sanicks, the shore is composed of the common red-coloured sandstone, intersected here and there with veins of basalt; but it is often so covered with boulder stones of different kinds, as to render travelling very difficult. The rounded masses of granite, scattered up and down here, are of a most astonishing size; some of them hundreds of tons weight. Near to the Sanicks, there is an immense stratum of breccia, which is composed of rounded fragments of quartz, and micaceous schistus, cemented by an arenaceous ground. The breccia is in many places much broken. Immense masses of it, many hundred tons weight, lying separated from the stratum only a few feet, render it probable, that these masses were disunited by frost. In one place, I observed, a considerable section of the breccia, which I examined very carefully, in order to discover if the masses of quartz, were compressed and smaller at the lower than the upper part, but no difference could be observed. Very remarkable instances of this kind have been observed

served in other countries; thus in Bergm. Erde-Besch. 182, we are told that in the mountains of Quedlinz and Portfiellet in Norway, which consist of an argillaceous puddingstone, the siliceous pebbles it contains, are observed to be compressed to the thickness of the fourth of an inch, in the lower parts of the mountains, but to increase in size and roundness in proportion as their situation is higher. Also in the Vivarois, the lowest strata of primitive limestone, have been found of the thickness of one-tenth of an inch; but in proportion to their elevation in the mountain their thickness increases, until at its summit, it arrives at thirty or forty feet. 1. Soulavie, 178. Ferber made the same observation in England.

At a little distance from the shore, is the entrance into the deep South Glen-Sanicks, which is about four miles long, running nearly E. and W., and bounded on both sides by lofty mountains. As I observed a considerable stream of water running through this glen, I determined to examine it, as it was probable that the strata would be well exposed. Having walked for upwards of a mile in the direction of the glen, I descended into the ravine formed by the water, but found still the usual red-coloured argillaceous sandstone. As we continued clambering upwards, I observed several veins of sulphat of barytes, some nearly four feet wide, traversing the sandstone;

stone; and, by a little care, I obtained specimens pretty well crystallized. About a quarter of a mile further on, a very compact arenaceous breccia (principally composed of rounded pieces of quartz, and a species of basalt, which has, interposed, grains of felspar, and a yellow substance,) makes its appearance; and this extends to a considerable distance; but it is at length apparently interrupted by a stratum of hornblende rock. This stratum of hornblende rock is only a few feet wide; and it appears to lie immediately on the granite. I have to regret that I could not obtain more satisfactory views of the junction of these strata, owing to the great covering of debris. I am somewhat confident, however, that the disposition of the strata is pretty nearly as now stated, viz. that in the lower parts, and for a considerable way upwards, is argillaceous sandstone; next, arenaceous breccia; then a bed of hornblende rock; and, lastly, granite.—The glen is now bounded by lofty granite mountains: on the N. is the Caimes, with part of Caime-na-caillich; and, towards the S., Keich-na-hien and Goatfield form boundaries awfully grand. Its sides are much furrowed by the action of the rain: which circumstance, with the red colour of the decomposing granite, the immense granitic blocks which cover the sides and tops of the mountains, form altogether a sterile and tremendous scene.

In

————— In lonely regions, here, retired
From little scenes of Art, great Nature dwells
In awful solitude.

Here I observed several veins of basalt traversing the granite; and, in some places, I could trace the perpendicular veins from the top to the bottom of the mountains. At the top of this glen is the hollow called Cory-na-huave, which is bounded by Caime-na-callich and Keid-voe. Its bottom is higher than that of Glen-Sanicks; and is entirely composed of granite, traversed with veins of basalt, some of which have a considerable degree of curvature.

Having examined this glen as far as my time would permit, I was again proceeding toward the sea-shore, when I thought it might be interesting to examine the junction of the granite and schistus in some of the neighbouring glens. I therefore changed my course, as soon as we came to the rock of breccia which I have just described; and from this I crossed over a hill of similar rock to North Glen-Sanicks. Here we observed a stream running through the glen, and in it I found the schistus in immediate contact with the granite. The schistus appeared to be a very compact micaceous rock; but the granite was not intermixed with it at the junction, nor were there any veins

to be observed shooting from the granite into the micaceous rock. We now crossed over the hills into another glen, where I observed another junction of the granite and schistus, but it presented nothing remarkable.

I now returned again to the shore, below the entrance of South Glen-Sanicks; so that I might proceed regularly on my tour through the island. After passing the Sanicks burn, I found the sandstone, breccia and basaltic veins still continuing; but the appearance of the mountains was much changed. The peaked summits, and almost perpendicular, furrowed sides, now disappeared: the mountains were clothed with heather to their summits, which were more or less round-backed: intimating an alteration in the materials of which they are composed; which is really the case, as the granite had now disappeared, the summits of the largest hills being of micaceous schistus, which, in some places, alternated with talcaceous schistus. I now wandered along a mile or two of shore composed of sandstone; when my attention was arrested by the remains of workings for coal, at a little distance from the sea-mark the Cock of Arran. This coal stratum, which is but of small extent, runs in the sandstone, accompanied by the usual coal metals, as, argillaceous ironstone, schistose clay containing numerous vegetable impressions, &c., and at the bottom of a
mountain

mountain of micaceous shistus. It is similar to that which is found at Kilkenny in Ireland, and is called blind-coal*. I observed two pits, about fifteen feet deep, which had been dug in cutting the coal stratum; but, as the coal soon disappeared, the pits were left, and the salt-pans which had been erected were rendered useless. The situation of this stratum is such, as to preclude all hopes of finding any considerable quantity of coal, although fresh sections were made: for we invariably find it to be the case, that wherever coal strata come into the vicinity of high mountains, they then most certainly decrease in breadth, and become bad, owing to the great admixture of earthy matter. Thus, many of the seams of coal which have been found in France are trifling, and continue but for a short way; owing to their situation, being found in vallies that are bounded by granite, or other primary rocks †.

K 2

The

* Dr. Hutton conceives that this species of coal presents an irrefragable proof of the truth of his theory. Here, says he, is a coal having all the properties of that which has been submitted to the action of heat; the bitumen is separated, and charcoal remains. To the Neptunists, this affords one of the strongest arguments against the theory. The separation of bituminous matter shows a want of immense compression, which is the grand fundamental basis of the hypothesis. It is indeed this circumstance, principally, which distinguishes it from the volcanic theory, and has led Mr. Kirwan to name it the Plutonic.

† Journal des Mines.

The great frequency of basaltic veins is another cause which may render the coal, if it should again be deemed worthy of attention, of an indifferent quality, and difficult to work.

From this stratum to the Cock, which is the most northern point of the island, the shore is covered with immense masses of sandstone and breccia, which have tumbled from the neighbouring hills by the action of the weather. Ironstone is found scattered upon the shore, and is probably connected with the coal workings. The Cock is not, as I expected, a headland, but merely an enormous mass of sandstone, lying loose upon the shore, having a fancied resemblance to the head of the cock. Here the cliffs are of considerable height, composed of sandstone and breccia, traversed with veins of basalt of various sizes. One of these veins is composed of a reddish brown-coloured basalt, with, interspersed, white-coloured, apparently crystallized spicstein of Werner; and the basalt, where it is in contact with the sandstone, is hard, and much resembles hornstone. After leaving this, a striking appearance presents itself to our view, of the whole face of an immense stratum of breccia, which was shattered to pieces, and rolled towards the sea, by an intense frost some years ago: the crash of its fall was heard far off. The sandstone upon this part of the coast is alternated with layers of shistose clay; and where the clay is washed away

away, the sandstone lies exposed, having the appearance of a regular pavement. If we examine it more nearly, we find the sandstone strata split into two, four, or six-sided irregular figures, and connected together by the clay, which gives it an artificial aspect; by the decomposition of the clay, the pieces of sandstone are separated, and lie scattered on the shore, and are apt to be taken for the work of art. From this to within a mile of Loch Ranza, the sandstone, as usual, forms the cliffs upon the shore, and is backed by mountains of micaceous schistus, upon which it rests. Here, however, the sandstone disappears, and the micaceous schistus now forms the cliffs, which become higher as we approach Ranza. At the place where the sandstone disappears, there is a great basalt vein, about thirty feet wide, running in a rock intermediate between ardesia and micaceous schistus. As we approach nearer to Loch Ranza, the sea has exposed several other similar appearances, but far more distinct than the first. These veins are of various sizes; some are curved in their direction; one, in particular, is forked, or divided into two branches, which run in very different directions through the micaceous schistus. A few hundred yards from the entrance of the Loch, the sea has formed an interesting section of the strata, which demonstrates, in a satisfactory manner, the relative position of the sandstone, limestone, and micaceous

caceous shistus. The micaceous shistus which forms the shore, is inclined at an angle of 45° and dips to the S. E.; the secondary strata, are inclined at an angle of 45° , but dip to the N. W. so that the two kinds of strata meet together, similar, as Hutton remarks, to the two sides of a lambda, or the roof of a house. The secondary strata are of red coloured argillaceous sandstone, (which sometimes appears passing into breccia :) which alternates with limestone. This limestone sometimes contains masses of hornstone, a fact, somewhat similar to the occurrence of flint in the chalk beds of England. Saussure remarks that hornstone is confined to the secondary limestone, quartz being the sporadic matter which he has observed in primitive limestone. Many other veins may be observed traversing the micaceous shistus, before we arrive at the entrance of Loch Ranza, but any detailed account of these would be but a repetition of what has been already mentioned.

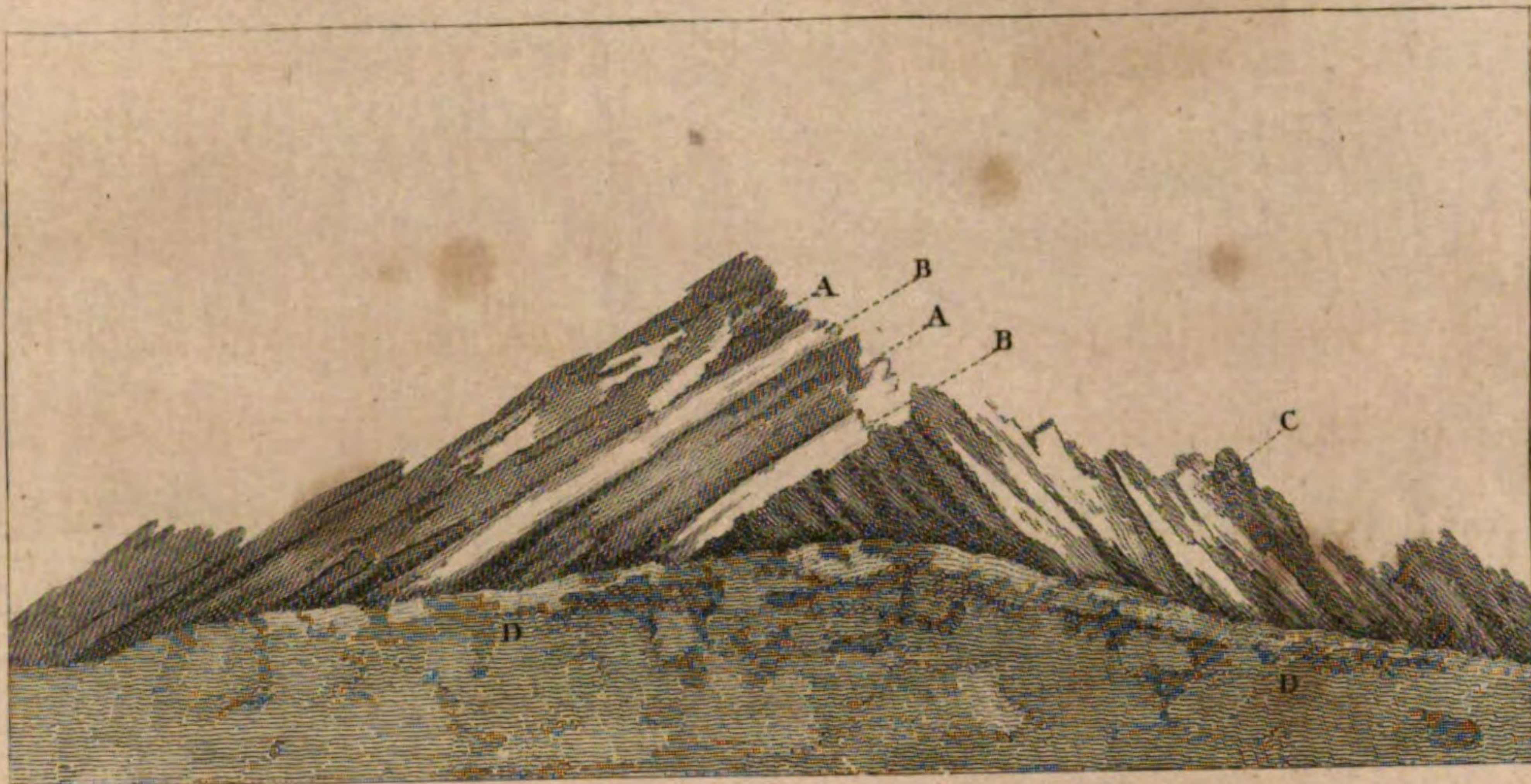
GLEN-RANZA. This glen is about two miles long, and half a mile broad, running nearly north and south, bounded on both sides by lofty round-backed mountains, that rise at a very considerable angle, and are nearly of the same height on both sides of the glen. The inclination of the opposite mountains is the same, and the strata run at the same angle.

The

The bottom of the glen is but little elevated, and nearly level; about one half is covered with a salt water loch, which adds greatly to the beauty of this romantic spot. The hills are composed of micaceous schistus, containing a greater or lesser proportion of quartz and mica; indurated chlorite is also dispersed through it, and towards the mouth of the loch there is a considerable stratum of ardesia, or primitive argillaceous schistus, bounded by the strata of micaceous schistus.

GLEN-ES-NA-BIRACH. From the top of Glen-Ranza, we enter, by a narrow passage, into a long deep glen, running nearly in the same direction, called Glen-es-na-birach, bounded on both sides, with mountains of compact micaceous schistus, which lie upon the granite. The granite and schistus are often intermixed at their junction, and sometimes small granite veins are to be observed issuing from the massive granite, and traversing the schistus. This latter appearance was considered by Dr Hutton, as a demonstration of the truth of his theory, with regard to the formation of granite. I will not now make any observations on this particular opinion, as I intend to consider it somewhat fully in a subsequent part of the work. As we advance further up the glen, the micaceous schistus disappears, when both sides are formed of granite, of the same kind with that of Goatfield. The bottom is also formed of granite, as is well demonstrated

demonstrated by the stream, or burn, which has laid bare the rocks through the whole extent of the glen; it is indeed by rivulets of this kind that we are often enabled to have a distinct view of the mineral structure of highland countries. From the further extremity of this glen, is the ascent to Caime-na-caillich, which is in several places rugged and difficult, from the number of loose blocks of granite spreading all around. Upon ascending, we first stop at the edge of what is called the Garife-hodie: Here a wonderful and most tremendous scene presents itself to our view. An immense hollow, many hundred feet deep, dreadfully rugged and broken, almost entirely surrounded with mountains, whose serrated summits are covered with immense tumuli of granite, exhibits to us, in very legible characters, the vast operations of nature, in the formation and decomposition of our globe. What man, possessed of reason, contemplating this awful scene, could doubt of the existence of that BEING, whose power and wisdom are far beyond the reach of human comprehension? If such a man exist, vanity, not soundness of judgment, is the distinguishing feature of his character. Few, indeed, of those who deny, or even doubt the existence of Deity, have ever beheld, far less studied, the stupendous and awful works of nature. It is not, then, much to be wondered at, that the pride and arrogance, which so often characterise the closet philosopher, should find
their



JUNCTION OF THE PRIMARY & SECONDARY STRATA NEAR LOCH RANSA

*A A Sand Stone B B Lime Stone Strata C Micaceous Shistus
D Basaltic Van*



R. Scott sculp

EAST SIDE of GLEN ROSA

their way to mix with their daring and impious speculations ; which have for their end the propagation of the worst principles, the dissolving of all the bonds, and destroying the sweetest endearments of human society.

Upon the edge of the hollow, I observed several fragments of porphyry, but I could not discover any fixed rocks of it, owing to the blocks of granite scattered all over the sides of the mountains. In ascending from this, to Caime-na-callich, several other appearances of porphyry, and also fragments of basalt and pitchstone, presented themselves. After considerable fatigue I was so fortunate as to discover two veins of basalt, upon the side of Caime-na-caillich looking into the Garife-hodie ; and, between these, there appeared a perpendicular vein of pitchstone, all running in the common granite. This pitchstone, is of a green colour, much resembling that from Bro-dick wood. It forms a vein, about two feet wide, and, what is remarkable, it is formed into two regular columns, from two to twelve inches diameter, and having from three to six irregular sides *. I could not, however, discover the situation of

L

the

* It would be worthy the attention of future travellers to determine whether the basalt be not included in the same vein with the pitchstone, thus forming a stratified vein.

the porphyry, although it was scattered in some places of the mountains in considerable quantities. Having gained the summit of this great mountain, which is nearly of an equal height with Goatfield, I had a very grand view; yet not so extensive as that from Goatfield.

Its summit has a most singular appearance, owing to its being covered with enormous piles of quadrangular masses of granite, which rest upon each other in a most fantastic manner, and have much the appearance of artificial tumuli. Such appearances are by no means peculiar to Caime-nallich, for I have already remarked them upon the top of several of the granite mountains in the island. Here we can trace the granite in its various stages of decomposition, from the solid rock to the loose sand; in its beginning disintegration it splits into masses, having a greater or lesser tendency to the quadrangular form; but these masses have still a degree of connection amongst themselves, as is the case upon the mountain top. The next step is the enlargement of the fissures, by which the masses are loosened from their connection, and tumble down from their elevated situations, upon the summits of the neighbouring mountains, or are hurried with impetuous velocity down the mountain side, covering the bottom of the glens with these stupendous ruins.

Lastly

Lastly, these detached masses, by the action of the weather, are completely disintegrated, forming a loose sand, which is left upon the tops or sides of the mountains, or is carried in great quantities to the sea shore by the torrents *. Saussure, at sec-

L 2

tion

* Dr Hutton remarks, that the stony matter of this globe has been formed by the decay of a former world, whose debris has been collected by various means, at the bottom of a former ocean. This part of the Huttonian theory differs but little from that of Count Buffon, yet it is so material for the general support of the whole, that if it shall be disproved, the solidity of the theory in general will be much impaired. If we examine a few of the numerous facts on this subject, we shall find no proof of the debris being carried to the fathomless depths of the ocean; on the contrary, we will observe it disposed of in a very different way. Thus in some cases, the loose materials washed from the mountains, are observed filling up great hollows; and in other instances, rivers deposit their earthy matters, and form extensive plains, and not unoften the debris having reached the sea shore, is thrown back upon the same or other shores. The following facts are in proof of these remarks. The plains of Crau and Camarque, in lower Languedoc, were formed by depositions from the Rhone, and the plains of Lombardy from that of the river Po; the lands of Holland and the Delta of Egypt, seem also to be depositions of the debris, brought to the sea shore by great rivers. In Egypt, the gathering of debris is very great, as is well authenticated by historic evidence: thus, we are told, that the town of Damietta, in lower Egypt, about the year 1243, was upon the sea shore, but is now about twelve miles from it: and the town of Foc-ah which, three hundred years ago, was situated at the mouth of the Nile, is now seven miles distant. The country about the Baltic is also gradu-

ally

tion 604 of his *Voyages dans les Alpes*, remarks, that granite is disposed in strata, but that they are not always to be distinguished, particularly in the granite of low countries and plains. This he conceives to be owing to the granite of low hills containing a great quantity of *pierre de corne*.

This

ally incroaching upon the sea. Linnæus remarks that the sea ports of east and west Bothnia are every year decreasing, and becoming incapable of admitting vessels; the inhabitants of the ports are obliged to change their seats, and sometimes remove a quarter of a mile nearer the sea. On the eastern side of Gothland, near Hoburg, the increase of the continent for these last ninety years, is about two or three toises annually. The inhabitants of west Gothland remark that the sea decreases every ten years four or five lines perpendicularly, which, amounts, to forty or fifty lines in a century. According to this calculation, 600 years ago the sea was 25 inches deeper than it is at present. In Arran we have also a striking proof of the formation of land by the accumulation of debris. Innumerable other instances might be mentioned. But we will not cite more, but conclude this note with the following ingenious observations from Mr Kirwan's *Geological Essays*. "Mariners were accustomed, says he, for some centuries back, to discover their situation by the kind of earth or sand brought up by their sounding plummets, a method which would prove fallacious, if the surface of the bottom did not continue invariably the same. Fortis in his *Travels through Dalmatia*, p. 285, relates that urns thrown into the Adriatic upwards of 1400 years, so far from being covered by mud, were found in the same situation, as they could have been supposed to have been the first day of their fall; therefore, notwithstanding many particles of earth are, by rivers, conducted to the sea, yet none are conveyed to
any

This pierre de corne, he continues, contains a great proportion of argillaceous earth; and as most stones, which have this earth as a constituent part, and in considerable proportion, split into rhomboidal masses, so he concludes that it is the earth of the pierre de corne which is the cause of the splitting of granite, thus forming the numerous masses which prevent us from observing the strata. This explanation, however ingenious, does not hold true with regard to the granite of this island: no argillaceous stone of that kind enters into its composition, yet still it splits into very numerous rhomboidal masses.

GLEN-HALIMIDEL. Upon the east side of Glen-Ranza there is an opening leading to a glen, named Halimidel, which is about any distance, but are either deposited at their mouths, or rejected by currents or by tides; and the reason is, because the tide of flood, is always more impetuous and forcible than the tide of ebb, the advancing waves being pressed forwards by the countless number behind them; whereas the retreating are pressed backward by a far smaller number, as must be evident to an attentive spectator; and hence it is, that all floating things cast into the sea, are at last thrown on shore, and not conveyed into the mid regions of the sea, as they should be, if the reciprocal undulations of the tides were equally powerful." Kirwan's Geological Essays, p. 440, 441.

about two miles long, running W. N. W. and E. S. E. but which soon changes its direction, running nearly in a line with Es-na-birach. It is narrow at the bottom, but widens upwards, owing to the inclination of the sides, which form an angle of about 60° ; and the bottom also rises, forming a considerable angle with the sides. It is composed of various species of micaceous schistus and quartz. In several places basalt veins may be observed traversing the micaceous schistus, many hundred feet above the level of the sea: even in the bottom of the glen, where the burn has exposed the micaceous schistus, we observe basalt veins crossing it. Upon the east side of the glen, several hundred feet above the level of the sea, there are two quarries, which were formerly worked for ardesia, but are now discontinued. The ardesia is of various colours; generally bluish or green, and is intermixed with white quartz; the fissures often contain crystals of actynolite, and a species of quartz penetrated with actynolite, forming a stone somewhat resembling prase.

A R R A N.

A R R A N.

C H A P. VI.

Description of the FOSSILS mentioned in the preceding Chapter.

LIMESTONE—Cory.

Colour. Grey.

Lustre. A very faint degree of lustre.

Transparency. None.

Hardness. Scrapes with a knife.

Smell. Emits a strong earthy smell.

Fracture. Even, fine, splintery, and very compact.

Fusibility. At 140° Wedgewood, no appearance of fusion.

Another species is also found at the Cory; of a dark-brown colour, minutely foliated, difficultly scraped with a knife, and wanting transparency.

LIME-

LIMESTONE—*near the Cock.*

Colour. Brick red.

Lustre. A slight degree of lustre from some dispersed foliæ.

Transparency. None.

Hardness. Pretty difficultly scraped with a knife.

Fracture. Generally foliated; passing to the compact earthy.

INDURATED LITHOMARGA?—*found loose on the shore between
Brodict Bay and the Cory.*

Colour. Light blood-red.

Lustre. None.

Transparency. None.

Hardness. Yields to the knife with considerable difficulty;
gives a pink streak.

Fracture. Even, bordering upon fine splintery.—Does not
stain the finger; feels dry; does not acquire a polish by
friction; after immersion in water for two days, no ap-
pearance of disintegration.

BASALT

BASALT—from a vein near the Sanicks.

Colour. Greyish green.

Lustre. None.

Transparency. None.

Fragments. Uneven earthy.

Hardness. Pretty easily scraped with the knife.

Fusibility. Melted at 58° .

BLIND - COAL.

KOHLENBLENDE, German. *NATIVE MINERAL CARBON*, Kirwan.

Colour. Black; when fresh broken, reflects a golden yellow, or violet colour.

Lustre. That of metals not much polished.

Hardness. Yields rather with difficulty to the knife.

Fracture. Plain foliated.

Is not coated with illinitions, as that from Kilkenny in Ireland. It does not stain the fingers.

Hardly burns until wholly ignited, when it consumes slowly,

M

ly,

ly, with a light, lambent, blue flame, which continues for a short time. According to Mr. Kirwan's method, it contains, in the 100 parts, 93 of carbon and 7 of ashes.

Mr. Kirwan, in the second volume of his Mineralogy, remarks, that coals are not soluble in acids. I have observed, however, that the coal of Arran is rendered soluble in water, by means of the nitrous acid, the carbonaceous basis appearing to be converted into an oxyd.

This substance has been placed in various parts of the mineral system, as with black-lead, molybdæna, manganese, &c.; but the late correct analyses that have been made, show it is carbon nearly in a pure state. Mr. Kirwan, upon consideration of its great purity, places it at the head of the coals, with the name of Native Mineral Carbon.

A R D E S I A.

ARGILLITE, Kirwan. *PRIMITIVE ARGILLACEOUS SHISTUS*.

DACHSCHIEFER, Emmerling. *ARDESIA TEGULARIS*, Linn.

Colour. Greyish blue, or greyish green; sometimes both colours are intermixed in the same specimen.

Lustre.

Lustre. Silky.

Transparency. None.

Fraçture. Streight, flaty.

Fragments. Tabular.

Hardness. Yields pretty easily to the knife.

Streak. Grey.

Does not adhere to the tongue; feels rather greasy, particularly the green-coloured; does not stain the fingers. There are often contained in the fissures, crystals of glassy actynolite.

MICACEOUS SHISTUS.

LEPIDOTES, Dr. Walker. *SHISTOSE MICA*, Kirwan. *GLIMMER*

SCHIEFER, Werner. *GNEISSUM MICACEUM*, Gmelin.

The few observations I have to make on this genus of rock should, in strict order, have been introduced in chapter second; but I wished previously to examine a greater number of specimens, so as to be better able to give a general idea of the whole.

It would be inconsistent with the brevity of this outline to

describe all the species of this rock: I shall therefore only mention it in general.

MICA. The mica, in general, is of a grey, or black colour; the scales very small, and indeed often hardly distinguishable.

QUARTZ Is of a white colour; is sometimes disposed in layers; and, in some specimens, has a granulated appearance.

TALKERDE, Werner; *TALCITE*, Mr. Kirwan; *LEPIS*, Dr. Walker. This substance occurs very frequently, indeed more so than the mica; yet, as I am not well acquainted with the names given to its admixture with other fossils, I still retain the term Mica for the whole, in speaking in general.

These three substances are often conjoined, forming a species of slate; in other examples we observe only quartz and mica conjoined, or quartz and talcite; and, lastly, felspar, indurated chlorite and hornblende add to its variety. In general, the rock which these substances make is very compact; and often they are so intimately combined, that it is difficult to determine whether it be mica, talcite or chlorite that is intermixed with the quartz. Frequently we see
the

the quartz a-wanting, when the mica passes to the state of ardefia.

USE, &c. Several kinds of this rock, particularly the quartz, have been used for the building of ovens and furnaces, on account of their great infusibility. No rock is more favourable for metallic veins; indeed, many of the richest mining countries are formed of it: we may instance the vast mines of Sweden, which are almost entirely situated in micaceous schistus.

A R R A N.

A R R A N.

C H A P. VII.

Glen-Catacol, Glen-Ersay, Glen-Glachan, Shiskin, Tory-Lin, Benin-Head, Whiting Bay, Lamlaish Bay, Lamlaish Island.

HAVING glanced over the glens and strata in the neighbourhood of Loch-Ranza, I will now proceed around the island by Glen-Catacol, which is about a mile and a half from Ranza. The shores in this direction are bounded by cliffs, which are neither very high nor rugged, but beautifully adorned with low shrubs, giving a richness of appearance seldom observed upon the shores of this island. The cliffs and mountains in the vicinity are formed of micaceous schistus, of various degrees of hardness, owing to its being more or less intermixed with quartz. They are separated from the sea by low beaches, of considerable extent, which, in some places, are cultivated. The entrance to the glen is bounded by lofty, precipitous mountains

tains of micaceous schistus; but this soon disappears, as the glen changes its direction, running N. N. E. and S. S. W.: then the mountains are formed of granite similar to that of Goatfield. In several places of the glen fragments of basalt occur; demonstrating the presence of veins traversing the granite, as we have already observed upon Caime-na-callich and Glenrofa. Upon one side of the glen we observed a narrow valley, into which we entered, but found that the granite was still the prevailing rock. At one place, indeed, I discovered great masses of porphyry; but I could not detect them *in situ*. It is probable, however, that it forms veins running in the granite, as the quantity of debris is too small for supposing the existence of strata. After a very fatiguing walk, I reached the top of the glen, when I observed a considerable plain, in which is situated a lake, about a mile long and half a mile broad, which is named Loch-Tan. It is bounded upon two sides by lofty granite mountains; but is open towards the others; one leading to Glen-Erfay, the other to Catacol. The margin of this partakes much of the sterility of the surrounding scenery: vegetation hardly shews its head: a few lichens and tufts of heather are the only ornaments of which it can boast:

A joyless coast.

Around a stormy lake.

Yet

Yet here the grandeur and sublimity of the surrounding granite mountains, enveloped in clouds and mist, excited in my mind a vast variety of ideas; for,

Surely there is a hidden power that reigns
'Mid the lone majesty of untam'd nature,
Controlling sober reason.

Upon ascending the granite mountains on the east side of the loch, I observed considerable quantities of the debris of basalt upon the top of the mountains, showing that the veins had reached to the very summit*.

I walked onward to Glen-Erfay, and, in my way, observed large blocks of a beautiful dark leek-green coloured pitchstone-porphry, remarkable not only for the number, but also for the size and beauty, of the crystals of felspar. I was not so fortunate as to find it forming a fixed rock in the neighbouring granite mountains; yet it is probable that future observers may discover it in veins, similar to that observed on the side of
Caime-

* Saussure observed fragments of greenstone upon the summit of Mont Blanc; very probably originating from a vein of greenstone which reached to the summit of this great mountain. Voyages dans les Alpes, tom. 7me, p. 280—288.

Caime-na-callich. Some mineralogists will rather be inclined to suspect that it alternates with granite: as this is said to be the disposition which it affects when among the granite mountains of other countries. According to Charpentier †, who made this observation, porphyry containing pitchstone alternates with granite near Meissen in Saxony. Dr. Mitchell, who was lately on the particular spot described by Charpentier, informs me, that he could not observe any such alternation, and therefore presumes that the observation of Charpentier is erroneous. Having reached the side of Glen-Erfay, I observed it taking its rise from the lower part of Caime-na-callich and the neighbouring mountains, and running, in an irregular course, towards the sea. It is said to be nine miles long, and is reckoned the most extensive glen in the island. Its sides and bottom are formed of granite, which continues until we come within a mile of the lower extremity of Loch-Erfay, when strata of micaceous and talcaceous schistus make their appearance. These strata continue to the entrance of the glen on the sea-shore; and here they are covered and succeeded by red argillaceous sandstone and sandstone breccia.

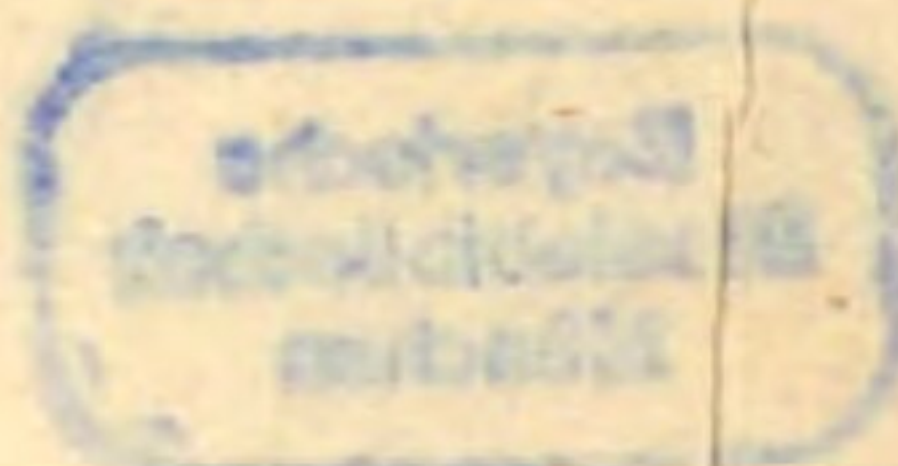
As

† Charpentier Mineralogische von Churfachsen, § 63.



As I had an opportunity, upon my former visit to this island, of walking along the shore from Catacol to the entrance of Glen-Erfay, I will now shortly mention the nature of the rocks that occur in this tract, and then continue the description onwards to the other parts of the island.

From Catacol to Whitefarland, a farm belonging to Fullerton of Kilmichael, the cliffs are low, composed of micaceous schistus, but defended from the action of the sea by intervening sea-banks similar to those noticed between Catacol and Loch-Ranza. Near to the farm of North Tundergay, I observed a remarkable vein of basalt penetrating the micaceous schistus. The micaceous schistus is much waved; but, as it approaches the side of the vein, it loses its shining glimmery appearance, breaks into thick plates, and, where in immediate contact with the basalt, it forms a compact kind of ardesia. The vein, as it rises from the sea, is fairly crossed by a species of micaceous schistus approaching to breccia; and here also the basalt and micaceous schistus are much jumbled together, and some pieces of the vein are apparently insulated in the micaceous schistus. Here, then, we have two facts; the former, the apparent transition from micaceous schistus to ardesia; the other, masses of basalt immersed in the micaceous schistus, in a similar manner to the basalt I observed embedded in the granite upon the east side of Glen-Rosa. At Whitefarland there is a considerable extent of
natural



natural wood, which adds greatly to the beauty of its appearance, which is much heightened by the lofty granite mountains that bound it on one hand, with the sea and long-extended isthmus of Cantyre on the other. From this to Imachar the same micaceous strata continue, forming beautiful cliffs and considerable sea-beaches. At Imachar the micaceous schistus is undulated, and traversed with quartz, so as to give the whole a kind of maculated aspect; and it continues to form cliffs until we come to the stream which issues from the entrance of Glen-Irfa. Upon one side of this stream I observed primitive schistus, but upon the opposite side sandstone cliffs make their appearance. These cliffs have a considerable beach interposed between them and the sea; and the strata of sandstone and sandstone breccia are elevated at a greater angle than any I have observed in the other parts of the island. The retreat of the sea from these cliffs is not only marked by the considerable beach we have just mentioned, but also by the caves which are dispersed in them. These cliffs soon disappear, when porphyry is to be observed; but we can only trace it a little way, the covering of grass preventing any further examination. The country is now low and flat, so that we have an easy walk to the house of the Shiskin; and the only rock I noticed was the red argillaceous sandstone, which I observed in the bottom of several burns: thus intimating that the whole strata over which I had

passed, after leaving the porphyry, was sandstone. At the Shiskin the land is low and flat. The mountains in the neighbourhood have a different appearance from those about Loch-Ranza; are lower; their sides less precipitous; in short, have much of the general aspect of those about Glencloy, all announcing a change in their composition. We have a good opportunity of determining the truth of this conjecture, in the Clachen glen, which is but a short distance from the Shiskin. The sandstone strata, which we have just mentioned as forming the low country around the Shiskin, stretches up the glen for a considerable way. At one place, on the south side, I observed a considerable stratum of limestone, which is covered, and even, in some places, intermixed, with sandstone breccia; and, nearer the upper extremity of the glen, shistose clay, richly impregnated with iron, makes its appearance. As we proceed upwards the glen becomes very deep; and, upon the north side, considerable rocks of clay-porphry occur, apparently covering the sandstone, as I conjectured may be the case at Glencloy and Corygills. As we approach still nearer to the upper extremity of the glen the sandstone disappears, when a sienite, similar to that at the head of Glencloy, is to be observed, and, so far as I could determine, rises to the summit of the neighbouring hills.

About

About two miles N. W. from the Shiſkin, after paſſing through a mooriſh flat, we come to Tormore, which is the promontory of this plain. Here are cliffs of conſiderable extent, which contain a range of extenſive caves, celebrated by tradition as the reſting place of Fingal, the father of our great Oſſian, who, it is ſaid, uſed to retire here after the fatigues of the chace. In the farther extremity of the greateſt, or what is called the King's Cove, are a few ſcratches, made by idle fiſhermen or ſmugglers, which, by ſome, have been referred to the Fingalian age.

As the appearances at this promontory are very intereſting, I ſhall make the deſcription as diſtinct as poſſible; and, to be regular, I ſhall begin at the north-eaſt end, or Machry Bay, and ſo on to Drumoodon point. The bay is of conſiderable extent; and the ſhore, all around to Irfa, is formed of ſandſtone. The bottom of the bay is a low ſandy beach; but, towards Tormore, it riſes, forming cliffs, which are continued all around to Rue-varey, or the columnar promontory, for the ſpace of about a mile and a half: and theſe cliffs are from forty to one hundred feet high. Between the cliffs and the ſea there is a conſiderable ſandſtone beach, which is remarkable for the great variety and the number of veins that traverſe it, in different directions: theſe, at firſt ſight, appear confuſed; but
a little

a little attention soon discovers a beautiful and distinct display of a most curious disposition of rock. As the pitchstone veins are the principal objects of curiosity, I will describe these first; and, to make the detail accord with the engraved plan, I will begin from the extremity of the great pitchstone vein as it rises from the sea, and so trace it back to near Machry Bay.

The great vein of green-coloured pitchstone, D, as it rises from the sea, is several feet wide, has a considerable inclination to the horizon, is slightly bent in its course, and traverses the common red-coloured argillaceous sandstone. It has, for some yards, the character of a *stratified vein*; that is, it contains layers or *stratulae* of different substances deposited in the same fissure along with the pitchstone. Upon the side of the vein next the sea, there is a layer, A, of a substance which appears inclined at an angle of 60° , dips in the same direction with the pitchstone D, and has a similar curve. It is not unlike a compact sandstone; but it is probably of the same nature with B on the opposite side of the vein, only more altered by the action of the weather and the sea. Upon the opposite side of the pitchstone, we observe a layer, B, which appears to be of the nature of hornstone, or, rather, verging to quartz: it has a similar curve and dip with the pitchstone. Immediately beside it
there

there is a thin layer of basalt, C, which is decomposing in balls; and this, again, is bounded by the common argillaceous sandstone strata. The vein continues thus stratified for about twenty yards, when the layers, A, B, C, appear to come nearly horizontal, and soon they entirely disappear under the debris. Further on, where the pitchstone is almost free from the covering of debris, it appears to be bounded on both sides by the common argillaceous sandstone; yet this is doubtful, as there may be small portions of the other stratulæ, which the debris prevents us from observing.

At a little distance from where the sandstone appears to form the side of the great vein D, we observe E, which is a vein of rock similar to that of B, is from six to eight inches wide, and is waved in its course. At some distance from this, there is a vein of basalt, P, about five feet wide, running nearly E. and W. which is much the same direction with the last mentioned vein. The next vein which we meet with is about thirty feet wide; runs N. W. and N. and N. E. and E. which is nearly in an opposite direction to the great vein. Upon one side, there is a layer, F, of a wax-coloured substance, intermediate between hornstone and pitchstone; next, is a layer, G, of high olive-green coloured pitchstone, about two feet wide; again, we have a layer, H, about half a foot wide, of the same pitchstone-hornstone,

hornstone as F; then, a layer of indurated clay, K; and, after this, the whole vein is formed of basalt, L. The sandstone which bounds this vein, in place of being red, the usual colour, is partly a yellowish-white colour. I endeavoured to discover its junction with the great vein D, but without success, owing to the great covering of debris: I observed it, however, upon the opposite side of D, but at a distance, entering into the neighbouring sandstone cliffs. At a little distance from this, we meet with another remarkable vein: the sides, M, M, are of basalt*; but the middle, L, is of breccia†. Still nearer to Machry Bay, another curious vein is to be seen: it is about eight feet wide; the sides, P, P, are of fine white-coloured argillaceous sandstone‡; next, are two layers, O, O, of basalt||, which

* This basalt does not differ from that from the south side of Glencloy, described at page 53.

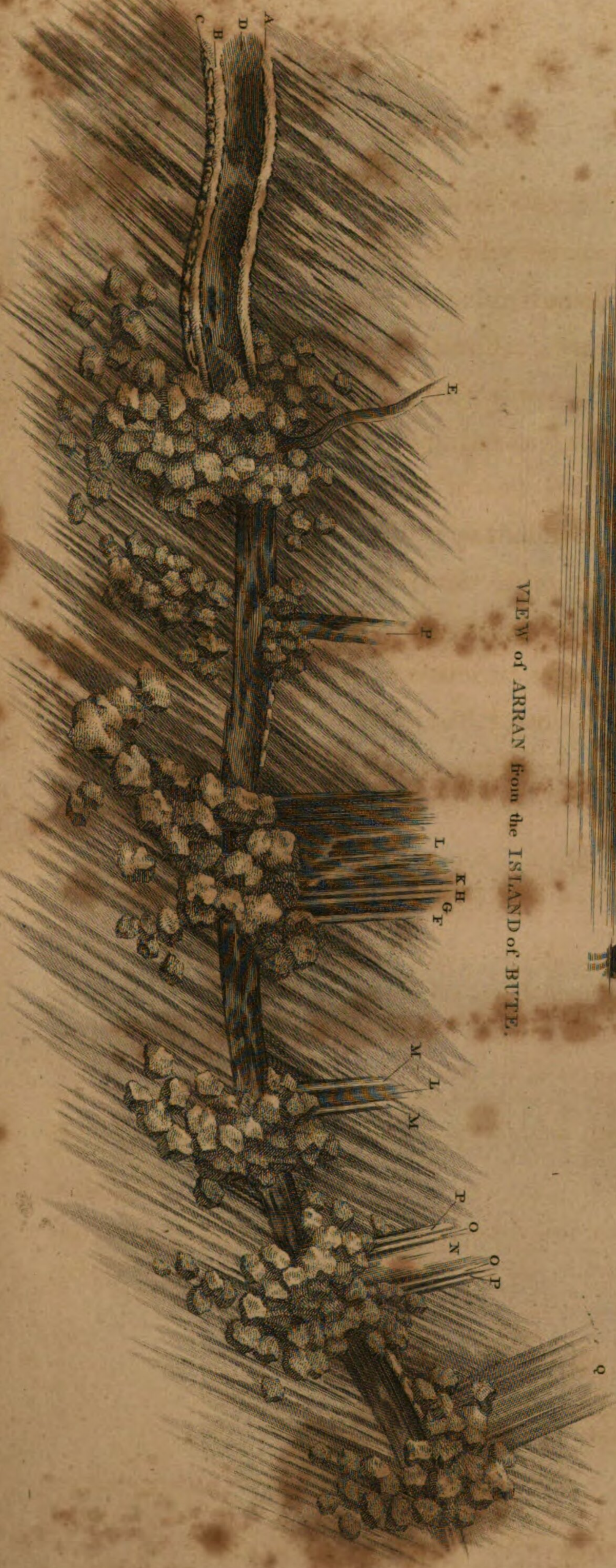
† This breccia is formed of variously-shaped masses of common and arenaceous quartz, and indurated clay, connected by a basis which is only an agglutination of smaller particles of the same kind.

‡ This sandstone only differs from the stratified kind by its having a white colour.

|| This basalt has a black colour; and has, dispersed through it, crystals of hornblende, calcareous spar, and iron pyrites: this last, by decomposition, often gives the whole a brown colour.



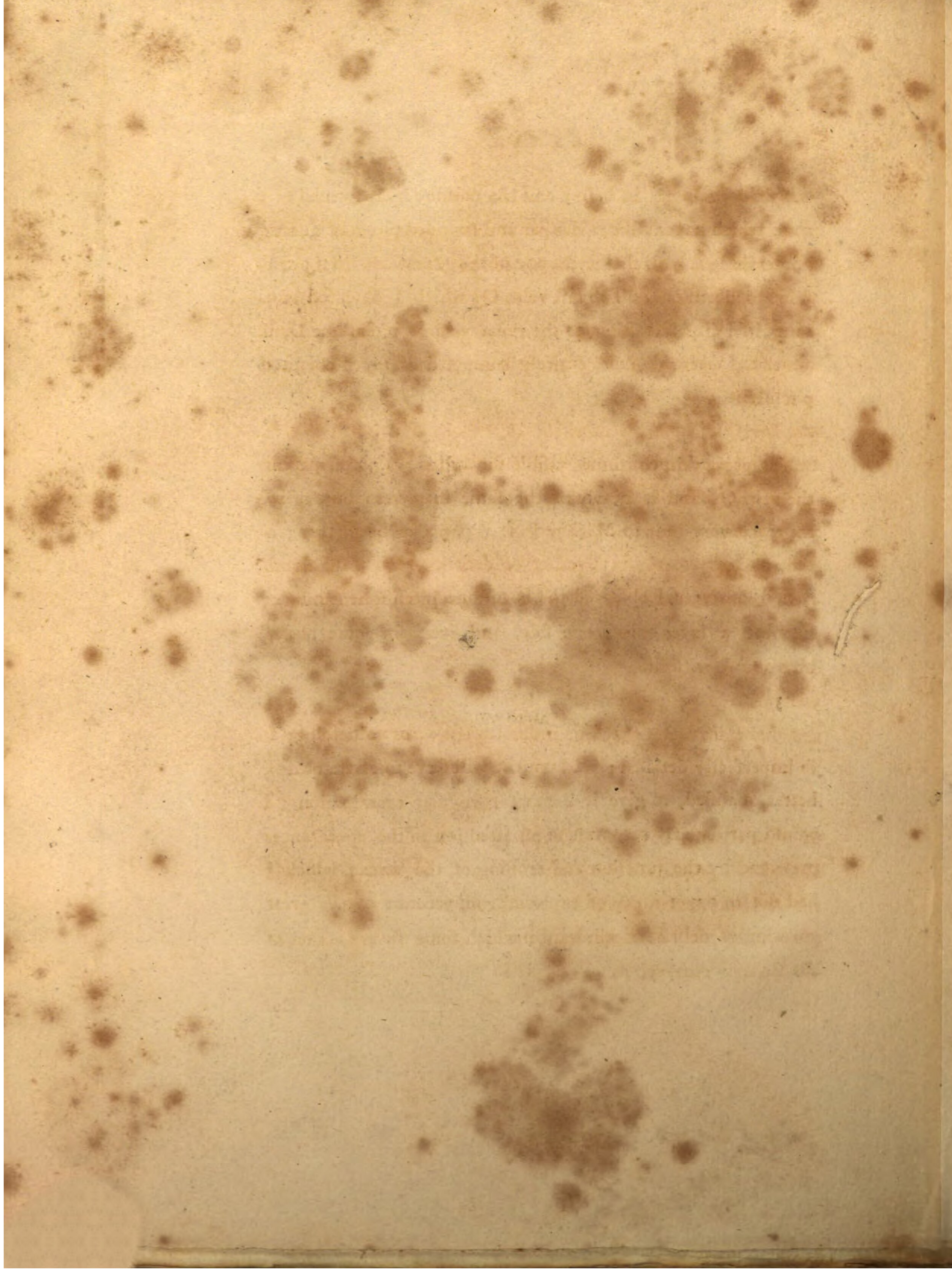
VIEW of ARRAN from the ISLAND of BUTE.



PLAN of the PITCHSTONE and other VEINS
TORMORE ARRAN.

W. H. Miller del.

W. H. Miller sculp.



which decomposes in balls; and the middle, N, is formed of a rock which has crystals of felspar and rounded pieces of quartz, immersed in a basis that seems one of the gradations from pitchstone to hornstone. The last vein, Q, which I observed running, in a cross direction, to the great vein of pitchstone D, is about ten feet wide, and entirely composed of green-coloured pitchstone.

The great vein continues visible for a little way after passing the vein Q, and is nearly of the same diameter; but, as we approach very near to Machry Bay, it is not to be further traced, on account of the covering of debris. Near to its termination, however, I observed the hornstone pitchstone substance forming a layer upon one side, and even, in some places, intermixed with it.

I have to regret that this interesting piece of mineralogy is so imperfectly detailed; yet I trust it will serve to excite others, better qualified, to give it a more particular examination. I would particularly recommend an attention to the appearances presented by the junction and crossing of the veins; which I had not an opportunity of exploring, on account of the great covering of debris: a hindrance which some future action of the sea may remove.

The next object which claims our notice, is, the determination of the relative position of the sandstone and porphyry. The cliffs, besides the sandstone, of which they are principally composed, are, in some places, varied by a clay-porphry, very similar to that of Glencloy; with this difference, that the crystals, felspar and quartz are larger. The porphyry, so far as I could determine, does not seem to lie on the sandstone, but merely to skirt it. Several basalt veins are to be observed traversing it, in different directions. One vein, about seven feet wide, runs through it in a perpendicular direction, and gradually narrowing towards the top of the cliffs, when it is lost among the sandstone that lies behind. Another runs more in a horizontal direction, and between the sandstone and clay-porphry. Another vein, which is nearer to Machry Bay than the other two, is to be observed running with porphyry on the one side, and sandstone on the other: it soon divides; one branch penetrating the porphyry, the other running between the sandstone and porphyry.

To the W. of the King's Cove, I observed great masses of green-coloured pitchstone scattered upon the shore; but I could not discover whether they belonged to the great vein D on the other side of the cove, or had been separated from other veins or strata. Upon the top of the cliffs, at the same place, I observed

served a variegated pitchstone, which was decomposed, in some specimens, almost to a brownish-white earthy powder, cropping through the grass; but I could not discover whether it formed a vein or stratum.

From this to within a short distance of the columnar promontory of Drumoodon, the cliffs are of sandstone; but, in some places, they appear covered with a porphyry: of this, however, I cannot say any thing satisfactory. I observed many basaltic veins traversing this sandstone; and, upon examining the connection of the veins and strata, I found the basalt and sandstone, at their junction, in several places, intermixed; and also the basaltic veins, besides the angle they form with the horizon, had a considerable inclination of themselves.

At a little distance from the columnar promontory, I observed low, shelving rocks of clay-porphry, which extend beyond the point Rue-Varey on the one hand, and seem to be connected with the porphyry on the other. The promontory is a striking object; is pretty high; and composed of red-coloured argillaceous sandstone, which is covered by irregular columns of a porphyry which, in some places, has much resemblance to basalt-porphry, in others is evidently clay-porphry. This fact is a presumptive proof that the conjecture I have

made, with regard to the situation of the porphyry of Glen-cloy and Corygills, may be true.

Having passed Rue-Varey, which is the most western point of Arran, we came to the farm of Drumoodon, which is situated upon the sea-shore, with a considerable sandy beach before it, and, behind, the sandstone cliffs are still continued. Here we find, resting upon the sandstone, a curious species of rock, having a tendency to split into columns; but of which I cannot give a determinate opinion, as I do not find any description, in the mineralogical works I have consulted, that corresponds with it. I have marked it, in the short description that is detailed in the following chapter, as intermediate between basalt and sandstone. These cliffs become gradually lower, and at length disappear, being succeeded by an extensive beach covered with fragments of the neighbouring rocks. After passing this beach, which forms one side of the plain of the Shifkin, considerable cliffs now rise before us, which are formed of clay-porphry of considerable height, but much split by the action of the weather, which gives an indistinct idea of stratification, similar to the granite observed in the Cory-Dain, at the head of Glen-Rosa. These cliffs contain several caves, but none of them are of any considerable size; and the shore is covered with great masses,

masses, which have been separated from the cliffs by the action of the sea and weather. These masses have a peculiarity of form, which characterises the rock from which they have been separated. This remark may appear fanciful; but several circumstances lead me to imagine, that one accustomed to observe with attention the debris upon the sea-coasts, &c. may often guess as to the peculiar nature of the rocks themselves, by observing the shape of the fragments. The whole shore, to Tory-Lin, appears to be composed of clay-porphry, and in some places sandstone is to be observed, and both are traversed with veins of basalt. I picked up fragments of dark leek-green-coloured pitchstone, in different places, among the debris of the neighbouring rocks; but had not leisure to determine its situation. From the Shiskin to Tory-Lin, there is a tolerable road; which is a rarity in this island, and extremely agreeable to the traveller, after having scrambled around the shore from Brodick Bay. The land now becomes lower, and has more of the rural appearance of the Lowlands of Scotland: agriculture is followed with some spirit, and even many of the sea-beaches are cultivated.

Tory-lin consists of a few houses, pleasantly situated in a hollow, at a little distance from the sea shore, and surrounded with

with sandstone hills. In the burn which runs by the houses, I observed veins of basalt traversing the sandstone in different directions, and amongst the boulder stones which cover its bottom, fragments of a light blackish green-coloured pitchstone presented themselves, showing the existence of veins or strata of that fossil in the neighbourhood. Upon the shore a curious species of porphyry, (different from wacken-porphry,) makes its appearance, and seems to be traversed with veins of common basalt, which are here of very great size.

On my second visit to Arran, I walked a-cross from Tory-Lin to Lamash harbour, which gave me an opportunity of observing a part of the islands, with which I was before unacquainted. I will therefore shortly mention what occurred in that route; before proceeding to mention the very few observations I made on the southern part of the island. After leaving Tory-Lin, we ascend for some time over the usual red-coloured argillaceous sandstone, it at length disappears, and the higher grounds are formed of porphyry. This porphyry continues until we come to the farm of Achariach, when red-coloured argillaceous sandstone is to be observed in the bottom of a burn, and is apparently traversed by a vein of white-coloured sandstone. As we proceed onwards, we ascend some high grounds, where the porphyry again appears, and it now
continues.

continues all the way to the hills upon the side of Lamlaſh bay. Theſe hills are compoſed of white-coloured ſandſtone at the top, but lower down of common red-coloured ſandſtone.

The ſhore from Tory-Lin to the Benin-Head, the moſt ſouthern part of the iſland, is principally compoſed of ſandſtone, traversed with veins of baſalt, which are ſometimes of great ſize, and run in a great variety of directions. The hills back from the ſhore appear to be entirely compoſed of porphyry*, but are not of any great height. The whole country to the Benin-head is conſiderably cultivated, and is here and there diverſified with ſmall villages, which give to the whole a pictureſque feature, which we have ſeldom an opportunity of obſerving in this iſland. At the Benin-head, the cliffs are of conſiderable height, and are compoſed of ſandſtone, porphyry, and baſalt. The porphyry and baſalt have a tendency to the columnar form, and both are traversed by baſalt veins, which are often of a great ſize.

From this to Whiting Bay, the cliffs are low, formed of ſandſtone, and traversed with baſalt veins, which run in a
great

* I find in my notes, that ſienite is marked as one of the rocks of this part of the country. I am now ſomewhat doubtful of that fact, and will therefore leave it as an object for future enquiry.

great variety of directions. The hills, however, up from the shore, now change their appearance, presenting broad, bare, perpendicular faces, similar to those which occur in all basaltic countries; and upon examination, we find them to be composed of various species of basalt,* lying upon a red-coloured sandstone, which is intermixed with grunerde, and a grey shistose clay. This basalt is often columnar, and the perpendicular crags, being scattered in various directions, and often rising in groupes above each other, have a pleasing effect. Near to Whiting bay, there are considerable rocks of greenstone of nearly the same species with that found near Corygills; it is not in any considerable quantity, and appears to be the rarest rock in the island.

At Whiting bay, the cliffs disappear, and are not to be observed until we come to the entrance of Lamlash bay; in their place we have an extensive beach, bounded by gradually rising sandstone hills, much traversed with basaltic veins. When the tide ebbs, the bottom of the bay exhibits a most astonishing collection of basaltic veins, which have been laid bare.

* Stucke, a German chemist, on breaking a certain cellular basalt, found the cells to contain water. He analysed 20 ounces of this water, and found it to contain fourteen and a half grains of fixx. *Stucke Untersuch.* 119. *Kirwan, Geological Essays*, p. 118.

bare by the action of the sea; here they are to be seen running in every direction, meeting and crossing each other in a most curious manner; in short, this is one of the best parts of the island for observing the various crossings, &c. of these singular appearances*. At the entrance of the bay of Lamlash, the sandstone forms considerable cliffs, which continue a short way of considerable height, but are gradually lower as we approach the village of Lamlash, where there is an extensive flat beach. These cliffs are also traversed with veins of basalt, and in some places a few hundred yards from the shore, I observed many detached masses of green pitchstone, indicating its existence in the neighbourhood.

Lamlash bay, which is the best harbour in the island, and one of the best in the Firth of Clyde, is of a semi-circular shape, and is formed in part by Holy island or the island of Lamlash, which lies across it, leaving two entrances, one from the north, the other from the south, which last is always preferred

* It will be somewhat difficult to explain the appearance of so many veins in so small a space of ground as Whiting bay, according to the Wernerian Theory. For surely had all these been at one time open fissures, the sandstone would not at the same time have supported itself. Saussure, imagines, that this objection may be removed, by supposing, that these fissures were formed successively.

ferred by mariners. It is bounded upon the Arran side by hills of red and white sandstone, traversed by basaltic veins. Upon the east side of the bay, attempts have been made to discover coal, but without success.

Lamlash or Holy island, is about three miles long, and half a mile broad, precipitous on the east, also considerably abrupt on the west side, but the north and south ends are low. It is composed of red-coloured sandstone, which is in some places formed into small caves; one is celebrated for being the residence of the holy disciple of St. Columba, St. Mool-jos, or the servant of Jesus. This sandstone is covered in many places with a species of basalt, very similar to that near Whiting bay, and with difficulty distinguishable from sandstone. I have been very much at a loss with regard to the particular denomination to be given to this rock; and I must still remain in doubt †. It forms in many places regular columns, generally six-sided, which rise range above range, giving a faint idea of the stupendous scenery of Staffa or Boshella.

† Saussure mentions a basalt much resembling sandstone, having a prismatic rhomboidal form, and containing hornblende crystals. Observations sur les Collines du Brisgau—Journal de Physique, An Deuxieme, p. 329.—Nay, even sandstone has been found columnar: thus the columnar boulastein, found in Iceland, is a sandstone.—Eggert Olafsen Reise durch Iceland.

la. Upon the west side, the columns are of greater size than upon the east, and the same matter appears to form the summit of the island, which is reckoned about seven hundred feet high. Upon the south-east part of the island, I observed a rock principally formed of crystals of hornblende, which is in some places traversed by basalt veins*, and also stratified with the common sandstone; and towards the south-west extremity, basalt veins are seen traversing the sandstone.

P 2

A R R A N.

* This basalt has a very great specific gravity, owing to its being abundant in iron.

A R R A N.

C H A P. VIII.

Description of the Fossils, occurring in the preceding Chapter.

PITCHSTONE—From Tormore.

THE following series of fossils affords us a curious example of the gradations, which we often observe between the different kinds of rock. These gradations were either overlooked, or but vaguely understood, until the time of Werner, who by the beautiful discovery he made in thus tracing the steps of nature, attracted the attention of mineralogists. An eminent mineralogist of our own country, has made great progress in this interesting enquiry, and it is to be hoped, he will soon gratify us with the result of his labours.

No. I.

PITCHSTONE—*from the great vein D.*

Colour. Brownish.

Lustre. Little glancing, and greasy.

Transparency. None.

Fracture. Uneven, approaching the splintery.

Hardness. Gives a few sparks with steel.

Quartz, and a reddish substance like garnet is dispersed through it.

No. II.

PITCHSTONE *passing to Hornstone.*

Colour. Light wax yellow, yellowish green, weak reddish brown.

Lustre. None.

Transparency. None.

Fracture. Even, splintery, sometimes uneven.

Hardness. Hardly touched by the knife.

Smell. Gives a strong earthy smell when breathed on.

Fusibility. At 55° was covered with a slight enamel; at 69°
became

became white, slightly softened, and was then somewhat porous. A fragment from a six-sided column softened at 81° , and at 118° a compact brown vitreous mass was formed, which had interspersed white grains.

By decomposition it acquires a white, and in some varieties a brick-red colour. It has dispersed through it crystallised and amorphous quartz, chalcedony, a very few crystals of white felspar, calcareous spar, and also minute dark leek-green-coloured crystals, probably pitchstone.

N^o III.

Fossil which appears pretty nearly of the nature of Hornstone, or rather verging a little to Quartz—from the stratulum B.

Colour. Pale blackish brown; or, dark grey, approaching to black.

Lustre. Very little glancing.

Transparency. A very slight degree at the edges.

Fracture. More or less fine splintery, and very compact.

Hardness. Gives fire plentifully with steel.

Pieces of quartz are dispersed through it, as in the former; and a few crystals of felspar now and then occur.

N^o IV.

Fossil still more nearly approaching to Quartz, which is intermixed with the green pitchstone of the great vein D.

This species of rock differs little in colour from the preceding; but has more lustre and transparency, and is a little harder. It acquires a white crust by the action of the weather. It has also, interspersed, crystals of quartz.

O B S E R V A T I O N S.

These different gradations are all to be observed in the same vein, and appear to graduate or pass into each other. Thus, the first, or brownish-coloured pitchstone, by its little lustre, seems verging to the second; and, in reality, we often observe, in the same specimens, the one passing into the other. The pitchstone-hornstone substance, N^o II. as its name implies, has partly the character of the pitchstone, and partly that of hornstone. The degree of fusibility intimates that it is sensibly different from the pitchstone, yet not sufficiently refractory for hornstone. Klaproth found a substance of this kind fusible; and Mr. Kirwan mentions a greenish-white hornstone, from Lorraine, which, from its being fusible, seems analagous to this.

We

We are sometimes so lucky as to find specimens where the second passes into the third; and often we observe the third passing to the fourth.

These four kinds of rock, then, present to us a complete gradation from pitchstone to hornstone; and we have a few steps towards quartz. In other countries, we have accounts of nearly similar appearances; and these I may shortly mention, as they will add fresh interest to the detail we have now given. Reufs informs us, that he observed pitchstone passing, by various stages, to hornstone, at Garfseback, near Meissen*. Esthner remarks, that the Saxon pitchstone passes sometimes to hornstone†. and Mr. Kirwan, in his Elements of Mineralogy, observes that it passes to hornstone.

CLAY PORPHYRY, *when passing to hornstone—Tormore.*

Colour. Greyish.

Lustre. None.

Tran-

* Sammlung Naturhistorischer Aufsätze, &c. von Franz. Ambros Reufs, § 362.

† Esthner, Mineralogie, B. ii. § 445.

Transparency. A little at the edges.

Fracture. Even, passing to the fine splintery.

Hardness. Gives a few sparks with steel.

It contains, immersed in the basis, crystals of common red felspar, and white felspar approaching adularia. The crystals are of considerable size; and this is one of the principal distinctions between this species and some of those found in Glencloy. It decomposes, in the form of a brick-red crust, similar to some of the stones which are intermediate between pitchstone and hornstone.

In other specimens, the porphyry, as it comes in contact with the veins of basalt, has a base considerably resembling it; and at the columnar promontory of Drumodoon, the specimens often cannot be distinguished from what is called trap-porphyry.

A substance intermediate between sandstone and wacken, having a tendency to the columnar form—Farm of Drumoodon.

Colour. Yellowish.

Lustre. None.

Q

Tran-

Transparency. None.—It feels much like a sandstone.

Fracture. Even earthy, with the appearance of rounded concretions.

Hardness. Gives a few sparks with steel: but it contains confused fragments of quartz, which may have been the cause of this.—Emits a strong earthy smell, when breathed upon*.

Fusibility. Melted at 79° .

OBSER-

* Lampadius has discovered that hornblende contains charcoal diffused thro' it; and Mr. Kirwan has shown that some species of pitchstone contain it. It is conjectured that it may exist in other fossils, and cause the peculiar earthy smell which we perceive by breathing upon them.

OBSERVATIONS TO BE MADE,

FOR THE FARTHER ELUCIDATION OF THE

MINERALOGICAL HISTORY OF ARRAN.

VEINS.

I. **T**O examine the basalt, wacken, and pitchstone veins, (which occur in so many parts of the island,) with a view to discover if they be *stratified*. We should describe accurately the disposition of the *stratulae* of such veins, as it will enable us to determine their relative antiquity: thus, according to Werner, the parts nearest the sides of a vein are the most antient, those in the middle the most modern, and the intermediate of a middle age.

II. In the examination of veins, it will be of consequence to observe how they cross each other; which, Mr.

Werner remarks, will enable us to determine their relative antiquity: thus, if two veins cross each other, the most modern is that which crosses the other; and, of two veins, the one which interrupts or stops the other is the most antient.

III. To examine carefully the country in the vicinity of veins, so as to determine if there be any beds of a matter similar to that which fills the veins. It follows, from Mr. Werner's theory, that we should generally observe such appearances.

IV. To examine if the sides of the veins be more or less hard; where in contact with the granite, micaceous schistus, porphyry, sienite, or sandstone.

V. To examine the basalt, and other veins, with a view to observe whether they contain petrifications, or even wood unaltered; also, if they contain boulder stones.

STRATA.

STRATA.

VI. To determine the direction and inclination of all the strata throughout the island; so as to know whether they have much the same general arrangement, and if they are frequently situated in a similar manner with the strata at the mouth of Loch-Ranza.

VII. To examine particularly the strata of sienite; so as to discover its connection with the granite, porphyry and micaceous schistus.

VIII. In examining the great glens, as Glen-Rosa, Sannicks, &c. it will be of consequence to examine very particularly as to the disposition of the granite in strata; thus either to confirm or refute the observations on the stratification of the granite.

IX. To discover whether the porphyry, which is observed among the granite mountains, be disposed in veins or strata.

X. To

X. To endeavour to discover the situation of the hornblende and paliopetre which is observed in blocks at the entrance of Glen-Rofa.

XI. In traversing the hills of micaceous schistus, to be careful in observing if any rocks of trap formation occur in strata.

XII. To determine the position of the breccia, with regard to the other rocks, at the head of Glencloy; and also, to examine, more particularly, the extent and position of the breccia of South Glen-Sanicks.

XIII. To examine very particularly the appearance of the granite, at its junction with the micaceous schistus and ardafia, in different parts of the island. In this investigation it will be necessary to observe, 1. If the schistus, where in immediate contact with the granite, be not harder than it is at a distance. 2. If veins of granite are to be observed stretching from the granite, and traversing the schistus. 3. If the granite veins have the same grain with that of the granite of the neighbouring mountains. 4. If the granite and schistus be irregularly intermixed at their junction. 5. If the granite and schistus ever alternate

alternate with each other. This Werner considers as a rare appearance. I have not observed it in Arran. 6. If the micaceous schistus, where it covers the granite, can be observed gradually changing its character, and at last, where in junction with the granite, not distinguishable from it: a fact which has been observed in other countries, and demonstrative of the granite and schistus being formed nearly at the same time.

BUT E.

B U T E.

CHAP. IX.

Outline of the MINERALOGY of the Island of BUTE; with Observations upon the Formation of the Bed of the CLYDE, and an Account of the Route from BUTE to the Island of JURA.

THIS island is about eighteen miles long; and the broadest part, extending from east to west, is five miles. It is seven miles distant from the island of Arran; but is separated from the district of Cowal by a channel which is only about half a mile broad, and, in some places, sixteen fathoms deep. Towards the north end it rises into hills of considerable height; but these are neither sufficiently high nor extensive to afford scenes so sublime as those which characterise the mountains of Arran. The southern part of the island is, in general, (excepting at its most southern extremity,) low, well cultivated, and, in several places, beautifully ornamented with wood, particularly

ticularly near to Mount-Stewart, the charming seat of the Marquis of Bute. Although this island be destitute of fine mountainous scenery; yet, the extensive cultivation, and the general appearance of bustle and life, form a striking contrast to the lone wastes of the island of Arran.

Rothefay, the only town in the island, is pleasantly situated upon the shore of a considerable bay of the same name. It is principally supported by the herring fishery, and a very considerable cotton manufactory.

The island seems to be traversed by three irregular vallies, which run from east to west. One crosses the island at the town of Rothefay; the second at Kaimes Castle, in the north; and the other at Cil-Chattan, in the southern part of the island.

The mineralogy of this island, so far as I examined it, does not appear to be particularly interesting: but a closer investigation may discover many things which escaped my notice; as I examined it in very unfavourable weather, and, besides, had the misfortune to lose the specimens I had collected.

R

The

The whole of the island to the north of Rothesay is composed of primitive rock, which rises into considerable hills about Kaimes Castle, the seat of Lord Bannatyne. This half of the island is pretty nearly surrounded by the neighbouring land of Cowal, so that the sea can have little power over its shores, which are indeed very low; but the narrow channel, as I have already remarked, is very deep. The strata, in general, are, micaceous shistus, ardesia, and shistose talc; and they alternate, and pass into each other. Sometimes we also observe chlorite; which is either massive, or forms a species of slate; and not unoften I remarked quartz, more or less penetrated with the chlorite, forming a dark-green-coloured stone, similar to that I found in Arran. In several places considerable veins of quartz are seen, traversing the strata in different directions; and sometimes they exhibit curious phenomena. I observed upon the sea-shore, about a mile and a half south of Kilmi-chael ferry, a vein of quartz which deserves to be particularly noticed. As it rises from the sea, it is very narrow; but it soon becomes wider, and then divides into several considerable branches, which traverse the strata in different directions. One of these branches presents an appearance similar to that observed in Glenrosa, in the island of Arran, and described at pages 38, 39. This branch, having traversed the strata for several feet, is interrupted by a mass of micaceous shistus; but it again

gain appears at a little distance, and still in its former direction. Masses of micaceous schistus are also to be observed in the midst of the quartz vein. The appearance of a mass of micaceous schistus, which is a fusible stone when compared with quartz, in the midst of a quartz vein, must be considered as decisive against the theory of Dr. Hutton: for it is impossible to suppose that it should remain unaltered in a heat capable of melting quartz, or keeping it in a soft state.

The basaltic veins, which occur so often in Arran, are also pretty common in this island, and are found from two to ten feet wide, traversing the primitive strata in various directions; and I even noticed them upon the top of the highest hills.

Near to Lord Bannatyne's castle there are several slate quarries, which have been worked for some time, and are still continued. These slates, however, are not so much used as those from Easdale, which are, even here, preferred for economical purposes. In some parts of Germany, as at Ruhla*, they employ a compact micaceous schistus for the roofing of houses; and

R 2

* Voight Mineral Reisen durch das Herzogth. Weimar. Th. 2. Sec. 24.

and it is preferred to some kinds of ardesia, from its great durability. Probably some species of micaceous schist, equally useful with that used in Germany, may be found among the hills in the northern parts of the island. Mr. May, the chamberlain of Bute, informed me, that trials had been made for lead in the northern parts of the island, but without success. This I reckon no satisfactory proof that lead is not to be found in the island; as, in all probability, the persons, employed to make the trials, were but little versed in the business.

The north side of Rothesay bay is entirely composed of primitive rock, so is also the north side of Scalpa bay, which is situated upon the west side of the island, and nearly opposite to Rothesay; but the south sides of these bays are composed of red argillaceous sandstone, and sandstone breccia. The junction of these primary and secondary strata, is therefore to be looked for in these bays.

The country between Rothesay and Cil-Chatan bay; which is the lowest, most beautiful, and best cultivated part of the island; is composed of strata of red argillaceous sandstone, and sandstone breccia, alternating with each other, and both are traversed with basaltic veins. Upon the shores, on both sides of this part of the island, there are inland cliffs, similar to those

near

near the north end of Arran, and in several places we remarked banks of coral and sea shells *, considerably above the high water mark. These appearances, as well as those that occur in Arran, are proofs of the land gaining on the sea.

From Cil-chattan bay, to the southern extremity of the island: called Gurroch-head, the face of the country is much altered; it now becomes nearly as high as in the north end, rising into irregular hills with abrupt perpendicular crags, that are almost characteristic of a basaltic country. From the little opportunity I had of observing this part of the island, I can only say in general that it is composed of argillaceous sandstone, stratified with basalt, and traversed by basaltic veins. The basalt is sometimes columnar, and frequently contains much hornblende. I was told that lime had been found in this part of the island.

GENERAL

* These banks are usually made of the *Millepora polymorpha*, of which there are many curious varieties.

GENERAL OBSERVATIONS ON THE CLYDE.

Having now finished the outline of the mineralogy of the iflands in the Clyde, I fhall make a few obfervations upon the mode which nature appears to have followed in the formation of the bed of the river, the rocks and iflands.

The appearance of iflands in any quarter of the globe, naturally fuggefts to the mind, the idea of fome powerful agent which has convulfed and broken the folid land, and formed it into detached maffes. This opinion is not fanciful, for appearances, in many countries, fhew us, that the greater number of iflands have been formerly joined together, and muft have constituted part of the adjacent continent. Thus, if we examine the rocks upon the oppofite fides of the Clyde, we fhall find a great fimilarity in their nature. 1. At Campbeltown, which is only a few miles from the extremity of the ifthmus of Cantyre, we obferve a fmall portion of fecondary ftrata, which corresponds to that upon the oppofite coaft of Ayrfhire. 2. The rocks upon the north and fouth ends of the ifland of Arran correspond exactly with the ftrata upon the north and fouth fides of the Clyde. 3. The north end of Bute is compofed of a fimilar rock with that of Cowal, and the

the southern extremity is composed of the same rock with the Cumbray islands, and these are of the same rock with that of the Largs, which is on the south bank of the river. These facts would seem to indicate, that the opposite banks of the Clyde were at one time joined together, forming a very considerable extent of solid land. If this be admitted, (and there seems little doubt of its truth,) we must now endeavour to discover what means were employed to break down the land.

Philosophers in their speculations on this subject, have generally mentioned two agents, which they imagine have produced these striking and awful phenomena; these are the waves of the ocean, and earthquakes. The first opinion has been strenuously contended for by the late Dr. Hutton, who affirms, that all bays, peninsulas, islands, &c. have been formed by the long continued action of the waves of the ocean. This speculation at first sight seems very plausible, but a more attentive consideration discovers to us a very exaggerated account of a comparatively partial operation; and this is indeed pretty evident from the following facts. The channel between Italy and Sicily, is nearly the same to day, as in the time of the Romans. The isthmus of Corinth has not been visibly altered for upwards of 2000 years. Scylla, of which Homer has given a correct description, is now nearly in the same

same state as when he wrote *. The ruins of Beritta, the favourite seat of Augustus, are still to be observed in their original situation, upon the bank of the sea, and so situated, as to be out of the reach of the waves †. Ancona built by the Syracusians, is still by the sea shore ‡. Here, then, we have instances of the land resisting the powerful waves of the Mediterranean for upwards of three thousand years.

Dr. Hutton who was aware of some of these facts, remarks, that “ Our land is wasted by the sea; and there is also a natural progress to be observed, which naturally takes place on this occasion; for the coast is found variously indented, that is to say, more or less, according as the land is exposed to this wasting and wearing operation of the sea, and according as the wasted land is composed of parts resisting, with different degrees of power, the destroying cause. The land, thus being worn and wasted away, forms here and there peninsulas, which are the more durable portions of that which had been destroyed around; and these remaining portions are still connected with the mainland, of which they at present form a part.

“ But

* Spallanzani's travels through Sicily, vol. 4. p. 172.

† Maundrell's travels from Aleppo to Jerusalem in 1669, &c.

‡ Maundrell, *ibid.*

“ But those promontories and peninsulas are gradually de-
 “ tached from the mainland, in thus forming islands, which
 “ are but little removed from the land. An example of this
 “ we have in Anglesey, which is but one degree removed from
 “ the state of being a promontory. These islands again, in
 “ being subdivided, are converted into barren rocks ; which
 “ point out to us the course in which the lost or wasted land
 “ upon the coast had formerly existed.

“ To be satisfied of this, let us but look upon the western
 “ coast of Scotland, from the islands of St Kilda to Galloway,
 “ on the one side, and to Shetland on the other ; in this tract,
 “ we have every testimony for the truth of the doctrine that
 “ is consistent with the nature of the subject. The progress
 “ of things is too slow to admit of any evidence drawn imme-
 “ diately from observation ; but every other proof is at hand ;
 “ every appearance corresponds with the theory ; and of every
 “ step in the progress, from a continent of high land, to the
 “ point of a rock sunk below the surface of the sea, abundant
 “ examples may be found. We do not see the beginning and
 “ ending of any one island, or piece of country ; because the
 “ operation is only accomplished in the course of time, and the
 “ experience of man is only in the present moment. But man
 “ has science and reason, in order to understand what has al-

S

“ ready

“ ready been from what appears ; and we have but to open
 “ our eyes and see all the stages of the operation, although not
 “ in one individual object. Now, where the nature of things
 “ will not admit of having all and every step of the progress
 “ to be perceived in one object, an indefinite progression in
 “ the various states of different objects, showing the series or
 “ gradation from a continent to a rock, must form a proof in
 “ which no deficiency will be found *.”

This is very probably a correct delineation of the mode
 which nature follows in altering the land, in some few in-
 stances ; but it cannot be general, as it would give an age to the
 world quite inconsistent with the Hebrew chronology ; we
 must therefore consider it as untenable. It may be reckoned
 unphilosophical thus to shelter ourselves under the cover of
 what has been, by some, considered a traditional tale ; when
 facts and reasoning should decide the truth of the argument.
 I am by no means of this opinion, and however unfashionable
 it may appear, I am firmly persuaded, that any chain of reason-
 ing, that does not coincide with that chronology, is false. As
 I have now proved the insufficiency of this theory, I might
 proceed to consider the other ; yet to prevent the sceptical,
 from the use of any undue argument, I will endeavour to show,
 that allowing Dr. Hutton's observations to be correct, they will
 be

* Theory of the Earth, vol. 2d. p. 265.

be found quite insufficient to explain the breaking of the land of the Clyde, &c. From the account I have already given of the nature of the strata upon both sides of the Clyde, it is evident, that the ocean, in its supposed action, has broken down the hard primary strata, in preference to the softer secondary strata; a fact which strongly indicates the agency of some other power than the sea. Thus we find a considerable portion of the primary strata carried away from the north end of Arran, and Bute, while the secondary and softer strata at the opposite ends of these islands, with the sandstone isles the Cumbrays, stand in the middle of the Firth, defying the rage of the waves. Further, if we look at the map, we will find that all the arms of the sea which are connected with the Clyde, in place of being situated in the secondary strata, upon the south bank of the river, are only in the north side traversing a mountainous country which is entirely composed of hard primitive rock. The great depth of these lochs or arms of the sea is very decisive against Dr. Hutton's explanation. Loch Fyne, at its upper extremity, nearly opposite to Inveraray, is about 60 fathoms deep: Loch Strevin, a small arm of the Clyde, almost inclosed at its entrance by the island of Bute, is yet 38 fathoms deep: Loch Goyle, situated further up the Clyde, is, at its upper extremity, where it is not a mile broad, about 37 fathoms deep: and Loch Long, near its head, is 28

fathoms deep. These lochs are far removed from any violent action of the sea, or of currents; so that it is impossible that they could have been formed as Dr. Hutton conjectures, allowing millions of ages for the purpose.

The other opinion which we have mentioned, viz. "that the land has been often submerged and broken by earthquakes," seems to afford us a less improbable explanation of the present state of the Clyde, than that advanced by Dr. Hutton. The frequent occurrence of earthquakes, in the different quarters of the globe, affords us numerous instances of the submergence and breaking of the land: yet we are acquainted with none so extensive as that of the Clyde. This, however, is of little importance; as it is not improbable, that these catastrophes were more frequent at a former period, than now. It would extend these observations to a great length, were I to enter into a detail of all the effects of earthquakes; I shall therefore only select a few facts as illustrative of the present opinion. In 1692, when the town of Port-Royal, in Jamaica, was destroyed by a dreadful earthquake, vast masses of land were sunk far beneath the level of the sea, and mountains of considerable extent sunk down, leaving in their place extensive lakes. In 1693, the island of Forca disappeared, being swallowed up by the ocean during a tremendous earthquake. In 1678, there was

was a great inundation in Gascony, caused by the sinking of a part of the Pyrenees: the mountains having displaced the waters, which exist in the cavities that are contained in the bowels of the earth. In the late most awful earthquakes that have ravaged Peru, large mountains have been divided into two parts and separated; others sunk down, when large and often bituminous lakes have risen in their place; and lastly in the earthquakes that devastated Calabria, there are instances of mountains sinking into the bowels of the earth*.

These facts entitle us to conclude, that at some former period, this country was convulsed by great earthquakes, when the beds of the Clyde, and its numerous lochs were formed, by the submergence of the solid land: at the same time Arran, Bute, &c. received their insular form, being part of the land that had escaped the power of the earthquakes. These islands, as well as the lands on both sides of the river, have, no doubt, since that period, experienced some alteration from the long continued action of the weather and the waves of the ocean.

Route

* The earthquake that was felt in Canada, in 1663, overwhelmed a chain of mountains more than three hundred miles long. Clavigero's history of Mexico, p. 221.—Kirwan's Geological Essays, p. 500.

Route from the Island of BUTE to the Island of JURA.

In travelling from the island of Bute to the Western Isles, we have the choice of different tracks, as may be seen from the map. That which we pursued, although not the most convenient, was yet interesting, as it allowed us to glance at a considerable extent of highland country.

Having examined Bute as much as circumstances would permit, we crossed the Kyles to a small house called the Kerry, situated in the district of Cowal. In crossing, we perceived, at a distance, several boats, filled with men dressed in black, slowly rowing up the foun. So unexpected an appearance did not fail to attract our attention; and we were told that it was a funeral procession to a burying-place in the adjacent mountains of Cowal. Surely we could have hardly witnessed a more striking scene. Mortality is at all times awful; but it was here presented to us in a most impressive manner. The wild and lofty mountains rising from the sides of the channel; the almost perfect stillness of the water, which could be faintly heard dying away along the shore; the universal silence, not even disturbed by the scream of sea-fowl—seemed as if nature was
unwilling

unwilling to disturb the performance of the last and melancholy services to the dead.

At the Kerry, the shore is adorned with sweetly-rising natural wood; so that we left it with regret, to traverse a country where grey, rugged mountains, and brown heaths, are the only objects to which our attention could be directed. Having walked for about five miles through a dreary mountainous country, principally composed of micaceous schistus, interspersed with chlorite, and traversed with quartz veins; we came to the next ferry-place, which is situated upon the banks of Loch-Fyne. We crossed from this to East Tarbet, a distance of about nine miles; and observed the mountains on both sides of the loch, all the way to Loch-Gilp Head; having the same general appearance, and being probably composed of similar rocks with Cowal.

East Tarbet is situated upon the narrowest part of the peninsula of Cantyre; for it is here only about two miles to the sea on the west side, which is called West Tarbet. There is a tolerable road from the east to the west side; which is of some use, as this is not only the principal thorough-fare to the islands of Ila and Jura, but boats coming from the Western Islands have their cargoes unloaded here, and then are drawn across the
isthmus,

isthmus, in preference to the circuitous and dangerous voyage by the Mull of Cantyre. It was once proposed to cut across this narrow neck of land; but the bad ground at West Tarbet inclined the canal company rather to cut a canal from Crinan to Loch-Gilp-Head, through a more considerable track of ground, but reckoned more favourable for shipping. The canal is now far advanced; but it is very probable that its utility will by no means coincide with the sanguine expectations that have been raised, by the company, and the country in general.

The country, about East Tarbet, is bleak and rugged. The hills rise to a considerable height; and are composed of micaceous schistus in the lower part, but gneiss is to be observed towards the summit, and now and then indurated chlorite is found among the debris. West Tarbet presents a more pleasing scene, from the natural wood that grows there with considerable exuberance.

From East Tarbet I now continued my journey towards the island of Jura, along the banks of Loch-Fyne, which is adorned with natural wood, giving a rich and picturesque effect to the high cliffs that rise above the road. The strata are, in general, micaceous schistus, in some places alternating with considerable strata of hornblende rock, and traversed by basaltic veins: and

I was

I was told that considerable limestone quarries were opened among the neighbouring hills, and consequently must be primitive limestone. In many places we observed persons cutting down the wood, for the purpose of making charcoal for the use of the iron forge near Oban. This is to be regretted; for, in a short time, the whole wood will be destroyed, and the country deprived of one of its greatest ornaments; and merely for the supply of the working of an iron furnace, that probably might be carried on equally well by a carefully-carbonized peat.

Having walked for several miles along the bank of the loch, we now changed our course, and crossed through a long, dreary moor, and over hills, when we descended to the plain at the head of Loch-Kilifled. The rocks are, all the way, of micaceous schistus, which is, in many places, quite disintegrated, the loose mica forming banks several feet thick. This mica, if free from iron, might be of considerable value; as we find Mr. Wedgewood using the fine white mica of Cornwall for the manufacture of porcelain and his very useful pyrometers †. It is therefore worthy the attention of the proprietors to examine the neighbouring country, where probably considerable quarries of colourless

T mica

† Journal des Mines, No. 3. p. 119.

mica might be found. At the head of Loch-Kilifled I observed a considerable stratum of blue-coloured, granularly-foliated limestone, stratified with micaceous schistus. The micaceous schistus is here frequently mixed with felspar, forming a species of gneiss difficultly distinguishable from sandstone.

After leaving this plain, we had a difficult ascent for a considerable way, but the tediousness of the track was a little relieved by the natural wood through which we passed; this, also, soon disappeared, when brown mosses, and grey, bleak hills, were again characteristic of the country. Having walked for several miles through this dreary and desert spot, we were suddenly stopped upon the brow of a hill, from which we had a view of the grey, sterile mountains of the mainland, rising into various rugged forms, and intermixed with lochs, thus presenting a wild and desolate scene. Soon afterwards, we came in sight of the rugged island of Jura, the island of Ila, and, farther distant, the mountains of Mull. These we viewed with much pleasure, as they were soon to be objects of our particular attention. We now descended from the mountains to the sea-shore; where we observed an old, gloomy, ruinous building, called Castle Swein, situated in a wretched-looking country. Even the few inhabitants we saw, had something so melancholy and depressed in their appearance; their miserable huts were in such unison with

with the scenery—as to occasion in us an unusual lowness of spirits. We hastened, therefore, from this spot, and crossed a small ferry, and then walked about three miles to the shore opposite the island of Jura. The strata, all the way from Kilisled to this place, seem to be principally micaceous shistus, frequently passing to talcaceous shistus.

We here were fortunate in getting a boat, in which we passed to the island of Jura.

We now examined a part of this island, and then crossed to Islla, where we remained a few days; and again returned to Jura, previous to our voyage to the Slate Islands. As it would be irregular, and little satisfactory, to detail the observations in the exact order in which they were made, I prefer first giving an account of Islla, and then of Jura.

ISLA T 2

ISLA AND JURA.

CHAP. X.

Abstract of the Mineralogy of the Islands ISLA and JURA.

ISLA.

THIS island is thirty-two miles long, and, in some places, nearly as broad. It is the most southern of the Æbudæ, or Hebrides; and its name is traditionally derived from Isla, the daughter of one of the kings of Lochlin, or Norway, who was buried in the parish of Kildalton. Dr. Campbell, in his Political Survey of Great Britain, remarks that it is the Epidium Insula of Ptolemy; and he imagines (erroneously, however) that it is denominated Isla, or The Isle, as being the seat of government when the Western Isles were ruled by the princes of the Isles.

It

It approaches somewhat to a square shape, and is much intersected by the sea, in particular by two considerable lochs, one on the west side, called Loch Graynard, the other upon the southern extremity, called Loch-in-daal. It is bounded upon the N. E. by the rugged and sterile island of Jura; on the E. by the isthmus of Cantyre; towards the S. it is separated only about 20 miles from Ireland; but on the W. it is exposed to all the violence of the Atlantic Ocean.

The cliffs around the coasts of the island are, in some places, of considerable height, particularly at Macarthur's Head, where they rise with great grandeur and magnificence. The shores are often covered with immense masses which have fallen from the neighbouring cliffs; but, in other quarters, the cliffs disappear, when we have shores bounded by considerable sandy beaches. Beds of cailloux roulés, or boulder stones, are to be observed upon the shore, but placed a considerable distance above high-water mark; and in the space of ground between the two lochs just mentioned, there is an extensive links, or down, where we find, under the thin covering of grass, sand, boulder stones, and shells. These appearances, which are proofs of the retiring of the sea from the land, are to be seen in many parts of the Western Islands.

This

This island, when compared with many of the Hebrides, is low; none of the hills being above 1700 feet above the level of the sea. The low grounds are pretty flat, often well sheltered; and, through the exertions of the present proprietor, Walter Campbell, Esq, of Shawfield, improvements are carried on with spirit: the mofs lands are daily rendered arable: thus beautifying the island, and rendering it the most productive of the Hebrides, its yearly rent being now about 10,000 l. *

MINERALOGY. To render the few observations I have to make on the mineralogy of this island distinct and satisfactory, I will first describe that species of rock which forms the interior, with its accompanying veins, and then trace the other strata around the coasts of the island.

Mining Field. The interior, or middle part of the island, from its containing a great number of metallic veins, and being the seat of all the workings, may be called the Mining Field.

It

* On the forfeiture of the Macdonalds, Ila, Jura and the lands of Muckrain were given to Campbell of Calder, upon condition that he would pay 500 l. of yearly feu-duty out of Ila. Campbell, about fifty years ago, sold these lands to the Shawfield family for 12,000 l. which is now their yearly rent: a most striking example of what may be done by spirited improvements.

It is entirely composed of blue-coloured limestone, which is supposed to occupy about thirty-six square miles ; extending in distance (so far as I could observe) to the sea-shore ; neither does it rise to any considerable height, for other rocks generally take its place when it rises to a few feet above the level of the sea. The limestone strata dip towards the S. W. Numerous symptoms of galena occur in this limestone, and several veins have been worked with considerable advantage. The principal seat of these workings seems to have been in the neighbourhood of Garthsnefs, which is situated about the middle of the limestone district. At this place there are the remains of a lead vein, which runs S. E. and N. W. and dips towards the S. Besides the galena, there also occurred, in the working, rich copper pyrites ; and it is said that, at one time, specimens of sulphurated manganese had been discovered. At Glasgow-beg there is another vein of galena, running E. S. E. and W. N. W. ; but it is traversed by a basaltic vein, which runs nearly S. S. W. and N. N. E. At a little distance southward from this, we observe an open cast vein, which runs E. and W. and dips to the S. : it is also crossed by a basaltic vein, as that at Glasgow-beg : the basaltic vein is about nine feet wide, and has thrown the lead vein about three feet from its original direction. There are many other mineral appearances besides these now mentioned ; but it would extend these notes too far to specify more of them.

Many

Many other basaltic veins are also to be seen: some traverse the metallic veins; others cross each other: in short, a plan of this mining field would represent a limestone district divided into a number of angular and square fragments.

The basaltic veins are of various sizes, from one to twelve feet in width. Many of them run parallel to each other; some run in a cross direction, marking, according to the manner in which they intersect, their relative antiquity †; and not unfrequently these veins stand up like artificial walls, owing to the limestone being more easily acted upon by the weather, and being consequently first carried away.

Besides the galena, considerable quantities of copper pyrites have been found, but the quantity too small to be of any consequence. Also, upon the south side of the limestone district, near to Loffit hill, iron ore has been quarried; but its situation is not yet well ascertained; and I am afraid, from the accounts I have heard, that it will be trifling. The workings in these veins have never afforded fluor spar; they produce only barytes and calcareous spar. Fluor spar is a rare production in Scotland:

† Werner Neue Theorie von der Entstehung der Gänge.

Scotland: I have only observed it twice; once in Shetland, as will be mentioned afterwards; and in a vein among the granite mountains of Aberdeenshire.

Before concluding this short description of the mining field, I shall mention two remarkable facts, which seem well authenticated.

1. *Silver*. It is confidently affirmed that a lump of capillary silver, weighing sixteen ounces, was found with the galena, in the vein at Garthsnefs. This is an interesting fact; and, should the veins be again opened, will prove a fresh incentive to carry on the working with spirit, as it is not improbable that veins of silver may be found. We know that scarcely three years have elapsed since native silver was discovered in Great Britain, and it is of consequence to observe, that it occurred in a situation somewhat analogous to that in Isla, the silver forming a string, branching from the side of a vein of galena †.

2. *Quicksilver*. A quantity of this valuable metal was discovered in a peat moss some years ago; and Dr Rotheram informs me that it is now in the possession of Mr Campbell. Some slight search has
U been

† It was at Hurland, in Cornwall, where this silver was discovered.

been made to discover its situation, but without success. This must not, however, be considered as a proof that no veins exist ; for, to determine this, it will require a more regular mode of investigation than has yet been pursued. Farther, the following facts show that limestone rocks are not unfavourable to the production of quicksilver : 1. It is found in globules, in white limestone, at Marsala, in Sicily ; (*Mineralogie Sicilienne*, par Borch, Turin 1780.) 2. Behind Guancavelica, in South America, the ardesia passes into limestone, which is rich in silver and mercury ; (Helm *Tagebuch reisen durch Peru*, p. 431.) In the mineralogical collection at Paris there are specimens of limestone, brought from the neighbourhood of Grenoble, which contain quicksilver*.

Observations. The mineral treasures of this island, from their being situated so near the surface, must have early attracted the notice of the inhabitants ; particularly as the Norwegians, the former masters of the island, were early celebrated as miners. We do not, however, find any mention of these mines, until the time of Boethius †, who wrote 300 years ago ; but

* *Journal des Mines de la Republique Francoise*, No. 1. p. 77.

† Boethius Scotor. Reg. Descript.

but even at that period they seem to have been of much consideration, for he remarks, "cum frumenti ferax, tum metallorum dives." Since that period they have passed through many hands; but do not appear, in any of them, to have been conducted with all the judgement necessary for so difficult and important a business. It is a matter of much regret that these mineral appearances, as well as many others, equally interesting, in different parts of Scotland, have not been prosecuted with more advantage. Many circumstances have contributed to this want of success; but, we apprehend, the principal one is to be found in the ignorance of the generality of miners, who are too often men of little education, and obstinately wedded to their own foolish practices. Even in Cornwall, where the mining business should be best understood, we observe them often working in an expensive manner. In Scotland particularly, wanderers from other countries, not regularly bred in the principles and practice of mining, have often imposed upon landed proprietors, by holding out to them flattering prospects of great gain, and have thus thrown a temporary obstacle in the way of improvement. It is to be hoped that the increasing taste for chemical and mineralogical studies will enable proprietors to treat such pernicious pretenders with that contempt they so justly deserve.

Having described the mining field, I shall now proceed to examine the rocks around the shores of the Island; and to do this with regularity, will begin at Portaskeg, a small harbour situated upon the sound of Isla. Here the cliffs are low, and composed of compact micaceous schistus; which passes either to Ardesia, or Gneiss; and in all these gradations, are to be observed, rounded or irregular shaped pieces of granite. This granite, which is composed of red-coloured felspar, and white quartz, and sometimes iron pyrites, cannot be said to be connected by a paste in the manner of a breccia, as the granitic masses and schistus pass into each other, showing that they have been formed at the same time. Ferber *, who has observed similar appearances in the mountains of Russia, agrees with Pallas †, in supposing that gneiss, micaceous schistus, and ardesia, are formed from the detritus of granite mountains; and upon this theory, he explains the appearances we are now considering. He conjectures, that the grosser particles of granite, having undergone a little alteration, are agglutinated in the form of granite, and inclosed by an aggregation of the smaller parts, which become argillified, forming the ardesia. This explanation is untenable, and unnecessary, when we consider

* New Transactions of the Imperial Academy of Petersburg, vol. 11.

† Observations sur les Montagnes, 4to. Peterburgh.

sider that after the greater part of the granite was precipitated, still a small quantity might remain, which would be deposited along with the ardesia, and form thin strata inclosed in it †, or irregular shaped dispersed pieces, as in the case at Portaskeg.

From Portaskeg the coast becomes gradually higher as we approach Macarthur's-head, and is formed for a considerable way of rocks similar to those I have just mentioned, which the sea has in some places hollowed out into considerable caves. As we approach nearer to this great head-land, the cliffs become much higher, and the micaceous schistus, &c. disappears; a granulated quartz taking its place *. Immediately upon the shore, I observed a large basaltic vein traversing the granulated quartz, rising up through it like an immense wall, and

† Karsten 3 Helvet. Mag. and Monnet 25 J. Physique, 85.

* Mr Mills, in his account of some strata in Ireland and Scotland, detailed in the Philosophical transactions of the Royal Society of London, for 1790, has given a description of Isla. As it differs considerably from the observations I am now to detail, it will be necessary as I proceed, to contrast our observations; so that future travellers, may be enabled to judge, who is in the right. Speaking of this part of the island, he says, "that it is composed of chert, which extends to Macarthur's-head.

and extending along the shore to a considerable distance; in some places forming a powerful barrier between the sea and a few cottages, which are built at the bottom of the cliffs. Having reached the head-land, I observed the cliffs rising to a great height, and composed of strata of arenaceous quartz, elevated at an angle of 45° ; and the rocks being tinged of a red colour, give a very wild character to the scene. This arenaceous quartz extends to a considerable distance; but is at length interrupted by a rock, which has much the appearance of a breccia, being composed of variously shaped pieces, (and some of great size) of the granulated quartz, connected by smaller particles of the same quartz; which has intermixed mica, and talc*. Frequently the whole has a red colour, which is owing either to the decomposition of the mica, or sulphuret of iron, which is sometimes dispersed through it. As we wandered along the shore, I observed this breccia interrupted by a vertical stratum of micaceous shistus: upon one side of the stratum, is the breccia; on the other, is the distinct granulated quartz. I would recommend this appearance to the particular attention

* Dr Townson in his travels among the Carpathian Alps, observed great strata of granulated quartz, (what he calls primitive sandstone) lying upon granite, and he observed it in all the states from fine granulated quartz to that of breccia, as in the case with the rock of Isla.—Travels through Hungary, 4to.

tion of future travellers, for I must confess, I was so fatigued when I reached this spot, that I could not give it that attention it undoubtedly deserves. The granulated quartz now forms cliffs along the shore, until we come to a small bay, where strata of micaceous shistus appear; and here the hills rise to a considerable height, being composed of micaceous shistus upon the lower part, and towards the summit, probably of granulated quartz. We now crossed over some higher grounds until we reached Ben-vinkie, which is said to be the highest hill in the island, although it is not more than 1700 feet above the level of the sea. The lower region of this hill is composed of micaceous shistus; but as we go upwards, granulated quartz makes its appearance; and upon the south-west side, which is very steep, a great vein of basalt reaches very nearly to the summit. The country becomes lower after passing this hill, and is pleasantly diversified with small irregular hills, that are intermixed with natural wood. The cliffs upon the shore are not very high, but are much broken by the action of the sea, which has formed many detached rocks; and these, having a grey colour, present a striking picture of sterility. Along with the micaceous shistus, we have now strata of ardesia, chlorite-slate, hornblende rock*; and these.

* These Mr Mill includes under the name of Hornstone.

these continue to Loch-Kunestle, a small harbour on the coast. At this harbour, we observed a low hill called Knock Kunestle, which is composed of ardesia, chlorite-slate, &c. in its lower part; but upon the summit, decomposing greenstone makes its appearance. I could not determine whether it forms a stratum or a vein; but observed, that when in a state of decomposition, it affected the compass at the distance of four feet. From this to Lugwillan, the coast and country continue rugged, and composed of the same rocks as those which extend from Macarthur's-head to Loch-Kunestle. This little village, unluckily for the traveller, is extremely wretched; presenting a sad picture, if not of poverty, yet of dirtiness and sloth. It would certainly be much for the advantage of the proprietors, as well as conducive to the comfort of the peasantry, if commodious houses were built, and strict regulations with regard to cleanliness enjoined. I mention with pleasure, that Mr Campbell, has already in part begun this meritorious plan, and it is not to be doubted that he will soon feel the advantages of it.

After leaving Lugwillan, we met with a small harbour named Leodamis, or Lowdinas bay, which affords shelter to small vessels; but like other harbours upon this coast, it is dangerous from the number of sunk rocks, which extend to a considerable distance. The rocks in this neighbourhood are com-
posed



L. Grant sculp.

VIEW of the GREAT CAVE of ISLA looking outwards.

posed of micaceous schistus, which by its decomposition forms a fine white sand, that covers the shore; and at the upper extremity of the harbour, I observed several pieces of melanteria, or black chalk, which seemed to have been detached from strata that probably alternate with the micaceous schistus. We now walked for ten miles, through a level country, to Lochlaggan, a sinuosity upon the side of Loch-in-daal. The rocks in this tract, are composed of micaceous schistus, and the general appearance of the country, to the extremity of the island, where it is terminated by the lofty Mull of Kishouth, announce a similarity of composition. From Loch-in-daal to the village of Bowmore, we passed thro' a level country, formed principally of micaceous schistus*, which appears, in some places, to alternate with greenstone. This last mentioned fossil, as also wacken, have been observed, in other countries, in a similar situation; but basalt, as Dr Mitchell informs me, is peculiar to the Stutzgebirge, or stratified mountains. We are, therefore, to consider the observations of the celebrated Charpentier † and

X

Faujas

* Mr Mills remarks, that the whole extent to Kishouth-head, and so on to Bowmore, is hornstone.

† 4 Helvet. Mag. 445. 546. Ibid. 3. 236. Charpentier, 81, 187.

Faujas St. Fond †, who assert that basalt strata occur in primitive mountains, as indicating only greenstone or wacken.—The village of Bowmore, which is the principal one in the island, is pleasantly situated upon the banks of the loch, and is the centre of all the business in the country. From this to Kiliru the roads lead through a flat country, part of which seems to have been gained from the sea. Near Kiliru is the seat of Mr. Campbell, which is pleasantly situated at the head of the loch, but is much exposed, from the want of planting. From Kiliru to the point of Runs, the island is in general low, excepting about the Runs, where it rises into hills, of which Bentarvil is the highest. Being disappointed in examining that part of the island, we crossed from Kiliru to Kilchoman. The country, in this direction, is low, interspersed with small lochs, and in some places well cultivated; and micaceous schistus, traversed with quartz veins, is the only rock that occurs. Near to Kilchoman, I observed an old, ruinous, gloomy building, which was once the seat of the turbulent Macdonald, prince of the Isles, but is now peacefully inhabited by the minister of the parish. From Kilchoman to the sea-coast, the country is low; and the rocks, which extend along the shore, continue to form low, broken cliffs of micaceous schistus, alternating

† Faujas sur le Trap, p. 86.

ternating with sand banks, until we come to Saneg-more. Here the cliffs rise to a considerable height: and, being much exposed to the ocean, are broken into many fantastic forms, presenting a grand and romantic piece of scenery. Knowing, from Mr. Pennant*, that there was a fine cave in these cliffs, we wished to examine it. Accordingly, having procured guides, through the goodness of Mr. Campbell of Sanicks, we descended a steep precipice to its entrance, when we found ourselves surrounded by lofty, rugged precipices, which towered far above us. The grandeur of the scene was much heightened by the turbulence of the sea, which came rolling in slowly, but with awful majesty, dashing among the rocks, with a noise that resounded on all sides like the discharge of artillery. Having entered the cave, we found it pretty extensive, but damp and black, owing to the water falling from above. At a little distance, the guides directed us into a narrow opening on one side, into which we scrambled with some difficulty, but found only a dark, dreary cavity, of little extent. As we walked onwards, the cave became larger; but we were soon stopped by a pool of water, which appeared to be pretty deep. The guides crossed through it, and walked to the further extremity of the cave; and the effect produced by the retiring of the lights,

X 2

* Voyage to the Hebrides.

was not the least interesting part of this scene. Formerly, when the cave was dry, the gentlemen of the country used to illuminate this wild grotto, and collect all the beauty of the isle to dance to the bagpipe.

We now left the cave; and, in our ascent, observed several basaltic veins traversing the micaceous schistus. From this to the mouth of Loch-Grynard, is an alternation of sandy beaches and low cliffs of micaceous schistus and ardafia, in some places traversed with basaltic veins, of various sizes, from a few feet to nearly forty feet wide. These appearances are so numerous, that I could not possibly afford time to examine them all minutely; so that it will not be surprising that after travellers should find, in some places, strata instead of veins. Loch-Grynard is of considerable extent; is usually bounded by sandy banks, but sometimes low rocks of micaceous schistus appear; and at its head are the links or downs we have already mentioned, which extend nearly to Loch-in-daal. From this loch to the great caves which are situated upon the north-west part of the island, the shore is, as usual, an alternation of low, rugged cliffs of micaceous schistus and sandy beaches; but, as we come nearer to the caves, the cliffs are much higher, and, in place of micaceous schistus, we have rugged precipices of granular quartz. We descended a path made in these cliffs,

cliffs, which brought us among rocks terribly broken by the sea; and after walking a few hundred feet, the caves presented themselves with much dignity. The height of the rocks in which they are situated; the wild and rugged grandeur of the neighbouring hills; the solitude of the place; all add fresh interest to this striking scene. The great cave, or what is called, in the Erse language, Ea-maur, is about thirty-three yards wide at its entrance, and from six to eight yards high: as we go inwards, the roof becomes higher, but it soon again contracts in all its dimensions; and about 150 yards from its entrance, it is so narrow and low, as to prevent any one from getting farther. It is situated in granular quartz, as is the case with the other smaller caves. The celebrated Sauffure has lately published a series of experiments upon the temperature of caves, in which he obtained some curious results. I repeated them carefully in the great cave, but did not find a difference of more than 8° of Fahrenheit between the temperature of the cave and that of the shade.

At a little distance from the caves, I observed the granular quartz covering a species of shistose talc, and, also, a species of marl, in the neighbourhood of the granular quartz and micaceous shistus: but I had not an opportunity of examining their relative position.

* Mr. Mills remarks that the caves are in rocks of chert.

position. From this we crossed a very fatiguing moor to Portaskeg: the rocks, all the way, are of granular quartz, (extending even to the summit of the highest hills,) excepting a few places upon the sea shore, where micaceous schistus appears.

J U R A.

THIS island is about 32 miles long, and 6 broad; but at Tarbet it is nearly divided, being only a mile and a half broad. It is bounded on the E. by Knapdale and Cantire; on the S. by the island of Isla; upon the W. by Colonsay, Oransey, Mull, &c.; and towards the N. the Slate islands. It is in general very mountainous, particularly upon the S. W. extremity, where are situated the high hills called the Paps of Jura. None of the Hebrides present such a mass of rugged barrenness. The hills are often grey and bare; and the scanty portions of the lower ground which are cultivated, seem ill managed. The shore upon the east side is in general low; but upon the west it rises frequently to a great height, and is broken into many striking forms; particularly we observe extensive caves, which afford shelter

shelter to the deer and goats that browse among the neighbouring rocks.

MINERALOGY. The mineralogy of this island, as far as I examined it, is but little interesting, as it does not differ materially from that of the shores of Isla. I shall not omit, however, to give a short account of it, as its mineralogy has not engaged the attention of any writer.

Immediately below Ardfin, the seat of the hospitable Archibald Campbell, Esq. I observed strata of granular quartz, inclined at an angle of 45° ; yet they are not regularly so, for I observed them inclined at different angles in other parts of the island. This rock forms the coast of the island all along the south of Isla, and, as far as I could observe, it appears to extend along the whole west coast. The cliffs are, in some places, of considerable height; and the great masses which are separated from them have, in general, a tendency to the pyramidal shape. This is another fact, similar to what I observed in Arran, showing that particular rocks break in such a manner as to be characteristic of their peculiar nature. These quartz masses, by further decomposition, fall into small crystalline grains, which cover the shore, in some places, to a considerable extent;

extent; and form a sand, which is assuredly among the purest that nature affords. It has been used with much success in the making of fine glass; and I have little hesitation in saying, that it is worthy of being more generally known as an article for glass-making: indeed it might also be advantageously used for the making of smalt, and different kinds of porcelain, in the place of powdered quartz, or flint.

Many basaltic veins are to be seen traversing these quartz strata, which extend along the found of Isla and the west coast of the island: and it is curious to observe the manner in which these two rocks decompose; for upon this circumstance depends the varied appearance of the rocky scenery on the west coast of Jura. Sometimes the basalt decays first, leaving only the empty space which the vein had formerly filled; and this afterwards is much enlarged by the decaying of the quartz: thus forming caves such as are represented in the plate. In other instances, the granular quartz decays first; and either falls away from the side of the basaltic vein, or is washed away by the sea: thus leaving the basaltic rocks extending across the beach like immense walls. These great masses of basalt are often broken into various shapes; but the



Engraved by R. Scott & Son

CAVES on the WEST COAST of the ISLAND of JURA.



Engraved by R. Smith, Edin.

*View of a PERFORATED BASALTIC VEIN. N.W. coast of the
ISLAND OF JURA.*

the most striking appearances are formed by the central part of the vein decaying first, which leave magnificent arches: but the engravings of this coast will convey a more lively idea of the character of these rocks, and the general appearance of the scenery, than any description.

There are many caves upon this coast, and some of them of vast size; but my time did not allow me to visit the most remarkable.—In wandering among the rocks, I observed several banks of coral sand; which I was happy at observing, as it will be of great use to this island, heretofore destitute of all kinds of calcareous matter, and abounding with much improvable peat moss.

PAPS of JURA. These mountains, which are the most elevated in the island, are distinguished by different names. The three most remarkable are, Beinn-a-chaolais, or, the Mountain of the Sound; Beinn-sheunta, or, the Hallowed Mountain; and Beinn-an-oir, or, the Mountain of Gold. The last mountain is the highest; being about 2600 feet above the level of the sea; and is, like the others, somewhat of a conical shape.

We clambered to the summit of one of these hills, but found the ascent very steep, and fatiguing, from the number of small loose stones that cover its sides: but our fatigues were

soon forgot in the immensity and variety of the prospect now before us. Immediately below was the rugged scene of the grey, storm-beaten rocks of Jura, interspersed with numerous lakes; conveying, as Mr Gilpin remarks, the idea of complete sterility. To the S. the island of Ila seemed spread under our feet; and, farther distant, appeared the coast of Ireland. To the W. we observed the small isles of Gigha and Cara, the isthmus of Cantyre, and the lofty red-coloured granite mountains of Arran, forming a striking contrast to the sombre hue of the mountains of Cantyre; and, still at a great distance, our view was bounded by the distant county of Ayrshire. On the N. E. we observed the wild alpine ridges of Argyleshire, extending all the way to Ben-Lomond. To the W. the Hebrides appear, scattered through the ocean: the isles of Colonsay and Oransey are in our immediate neighbourhood; farther distant, is the mountainous island of Mull, the celebrated I-colmkill, with the adjacent isles; and the long-extended isles of Coll and Tirie appear like a haze in the horizon.

These mountains are principally composed of strata of a granular quartz, elevated at an angle of 45° , and dipping to the south-west. From the summit of the hill, the strata appear to run in different directions; some curved, and others nearly horizontal: these appearances, however, are probably more owing

owing to the situation from which I viewed them, and the ends of the strata being worn down by the rain, &c. than to any alteration in their dip or direction. The fragments of rock which cover the sides and tops of these mountains, are broken into small angular fragments; which, observed at a distance, and even with a telescope, would show us, that they are formed of a rock very different from granite; as the latter almost always decomposes in large rhomboidal masses.

I frequently observed masses of this granular rock; which, from its containing felspar and mica, is to be considered as a true granite. This fact, will be reckoned, by certain geologists, as decisive against the opinion of Mr Werner; who affirms, that granite is the oldest rock, and consequently, that upon which the others rest. It cannot be denied, that there are several facts, detailed by the most intelligent geologists, which show, that granite is sometimes of a cotemperaneous formation with ardesia *, micaceous schistus †, and gneiss ‡; yet they are so rare, that I can only conclude from them, as I have before mentioned, that after the greater part of the gra-

Y 2

nite

* Reufs Mineralogische Geographie von Bohmen, B. 2. 180.

† Journal de Physique. New series, vol. 1.

‡ Emmerling's Mineralogie, B. 3.

nite had been precipitated, still a small portion remained in solution; and was afterwards deposited along with the gneiss, or other primary rocks. The opinion of Mr Werner, on the other hand, is supported by so vast a mass of evidence, as bears down all opposition. Thus, according to Saussure, the granite of the Alps, excepting in one or two instances, is always covered with other strata; itself forming the interior, and often the highest parts of the mountains. The same observation has been made by Baron Born, and Esmark in the mountains of Hungary and Wallachia; by Palaffo, La Peyrouse, and Carbonieres in the Pyrenees; by Reufs in the mountains of Bohemia; Lazius in those of the Hartz; by Patrin, Herman, Pallas in the vast extended empire of Russia; by the French mineralogists in all the granite mountains of France; also in the granite mountains of the West Indies, and in the few which have been examined in England † and Scotland.

Having mentioned the different kinds of rock which form the coast and hills, from Ardfin, along the south and west parts of the island. We will now proceed along the eastern shore

† In the great mine in Cornwall, called the Cooks Kitchen, I have been told, that the granite has been found above the ardesia (or killas). I have not as yet had it accurately confirmed.

shore, from the same place. Upon the shore, at a little distance from Ardfin, strata of micaceous shistus, alternating with rocks intermediate between talcaceous shistus and ardafia, appear, and continue forming low cliffs along the shore to the harbour of the small isles *. These rocks are sometimes very compact, and have a tendency to break into irregular columns; so that in some points of view, they are not unlike columnar basalt: we also observed basaltic veins traversing them in many places. From this the country gradually rises as we approach the high hills, the paps of Jura; and in some places, as upon the road leading from Ardfin to Small Isles, chlorite-slate is to be observed alternating with the other rocks. This chlorite-slate, sometimes passes to hornblende rock, by a mixture of green hornblende; and it sometimes contains calcareous spar, and crystals of yellowish-green actynolite dispersed; but this latter is a rare appearance. Not unoften I observed the chlorite penetrating the quartz, forming a dark green coloured stone; and here I was so fortunate as to discover that rare fossil, the crystalized chlorite, of which a particular description is given in the following chapter. If we still continue our course towards the high hills, we
at

* About a mile distant from Ardfin, we landed upon a small low island, which is composed in general of a coarse talcaceous shistus; and between the strata we observed layers of beautiful hornstone.

at length find the granular quartz rising from under the micaceous schistus, at an angle of 45° , and from this, the whole country to the summit of the mountains is formed of the same rock.

We would naturally conclude, from finding the quartz strata lowermost, that it had been deposited before the micaceous schistus; this is only true in part, as we sometimes observe the micaceous schistus passing to granular quartz, at a great distance from the junction †.

As far as my experience goes, mountains of granular quartz are to be considered as rare occurrences in Scotland: in Caithness, I observed quartz mountains, as will afterwards be mentioned: and Mr Williams tells us of quartz mountains in Rosshire*: but these are the only instances I am acquainted with. It is even an unfrequent rock in other countries; in the Carpathian Alps, Dr. Townson informs us, he observed what he calls primitive sandstone lying upon granite; and Mr Deriabin, to whom I showed the Jura rock, assures me that it is similar

† In Brainsdorf, in Saxony, granular quartz has been observed passing into micaceous schistus. 2 Crell. Beytr. 64.

* Williams's Mineral Kingdom, vol. 2. p. 52.

similar to that which forms so great a portion of these mountains.

As the discovery of limestone would be of much service in the agricultural operations of this island, we were anxious to ascertain if any such strata existed between the Small Isles and the Sound of Isla. To determine this, we examined not only the shores, but the ravines upon the sides of the hills, yet without success. This failure in our researches does by no means imply that limestone does not exist in this district, particularly when we recollect that these rocks are not unfavourable to it. We have many instances of limestone being found in micaceous schistus, in different parts of Scotland, as at Dalmally, near Blair in Athol, &c. ‡ It may even occur in granular quartz; as Escher has observed limestone among granular quartz in the valley of Reufs.—Townson upon the granulated quartz (primitive sandstone) of the Carpathian Alps, &c.

The harbour of the Small Isles is rendered pretty safe by three

‡ Werner has observed limestone alternating with micaceous schistus and ardemia, in Saxony: so has Charpentier, and that in great strata. Werner, Kurze Classific. 14. Charpent. 55, 56, 57, 174, 201, 400.

three or four small islands, that defend it from the violence of the sea. It will admit vessels of several hundred tons; yet, as the island and the neighbouring country are but thinly inhabited, few vessels are to be seen enlivening this solitary scene. The country in the neighbourhood rises gradually as it approaches the Paps of Jura, which here present a magnificent and striking mountainous scene. The strata, from the shore to the vicinity of the Paps of Jura, are composed of micaceous shistus; excepting at one place, about half a mile north from Mr Macnicol's house, where we observed a stratum of ardesia tegularis (roof slate) cropping through the heath. This stratum, which appears to be of considerable breadth, is bounded by the micaceous shistus; and, near the junction, the micaceous shistus contains cubical crystals of iron pyrites*.

From the Small Isles to Luggan, the strata of micaceous shistus still continue, often very compact, and frequently traversed by basaltic veins. At Tarbet, which is the narrowest part of the island, the land immediately upon the shore is low; and the eye is refreshed by the appearance of a beautiful

* May not the presence of cubical pyrites, in micaceous shistus, be indicative of the vicinity of ardesia tegularis?

tiful green flat, at the bottom of the grey hills which bound the shore. From this to Kenawochrach, the northern extremity of the island, micaceous shistus appears to be the general rock, but it is sometimes alternated with ardesia regularis. At one place the ardesia has been quarried; and, from what we could learn, there can be little doubt that, with well-directed experience, the working may become of consequence.

ALSI

GRANULAR QUARTZ.

CRANE, Dr Walker's Class. Fossilium. Primitive Sand-
stone, Mr Kirwan's Geological Essays, p. 208. Quartz.

Ibid. p. 179.

This rock, which we have so often observed in the islands of the and Jura, is described by Dr Walker under the name of Cranner Jura; and, more lately, Mr Kirwan, in his Geological Essays, describes similar rocks under the names of Ardenne-ous Quartz and Primitive Sandstone. There are many species of this rock in these islands; but I will only mention three of the most remarkable.

I. Com.

ISLA AND JURA.

CHAP. XI.

Description of the FOSSILS mentioned in the preceding Chapter.

GRANULAR QUARTZ.

CYAMEA, Dr Walker's *Classes Fossilium*. *PRIMITIVE SANDSTONE*, Mr Kirwan's *Geological Essays*, p. 208. *QUARTZ*, *Ibid.* p. 179.

This rock, which we have so often observed in the islands of Isla and Jura, is described by Dr Walker under the name of *Cyamea Juræ*; and, more lately, Mr Kirwan, in his *Geological Essays*, describes similar rocks under the names of *Arenaceous Quartz* and *Primitive Sandstone*. There are many species of this rock in these islands; but I will only mention three of the most remarkable.

1. COM-

1. **COMPACT.**

Colour. White, or grey.

Lustre. Little glancing.

Transparency. Transmits light at the edges; but when the specimen is thin, the light passes through the whole.

Hardness. Strikes fire with steel.

Fracture. Even, coarse splintery, and frequently shiftose in the gross.

Intermixed with quartz, (which is so compact as to render the granular character difficultly observable,) I always observed a number of white specks, which are either felspar or mica, or both, usually in a state of decomposition. Sometimes veins of compact quartz are to be observed traversing this species.

2. **MICACEOUS.** This species is composed of quartz, and a small portion of mica. The mica is always in small scales, and is either yellow, brown, or white. Often the mica is so abundant, that we have a true micaceous shistus.

3. **GRANITIC.** In this species, the granular appearance is more evident: and, intermixed with the quartz, are numerous crystals of red and white felspar, of various sizes, from a pin-

head to half an inch ; and a few scales of mica also, now and then, occur. Not unoften cubical crystals of iron pyrites are intermixed with the other ingredients, and, by their decomposition, cause the stone to acquire a brown colour, or to disintegrate altogether. This species, therefore, is to be reckoned an approximation to the granite, from which it differs but in the proportion of felspar and quartz.

MICACEOUS SHISTUS.

This rock occurs in Isla and Jura, and is considerably varied in its appearance. The quartz is of various colours, as black, blue, or white ; and is generally granular. The mica is also of different colours, as black, brown, greenish, or white : the scales are, in general, small ; the largest are those in the rocks in the strata that extend to the north end of Jura. The micaceous shistus at Lag in Jura, at a distance, is not unlike basalt ; but a nearer examination discovers a compound of black and dark-blue coloured quartz, with small scales of black mica very closely compacted together. It often also contains iron pyrites, which, by its decomposition, forms a number of rust-coloured spots. Sometimes crystals of felspar occur when it passes to gneiss ; or the quantity of quartz particles increase when it passes to the state of arenaceous quartz.

ARDESIA.

ARDESIA.

Colour. Bluish or blackish grey.

Lustre. Silky. This silky gloss, Mr Kirwan remarks, intimates magnesia.

Transparency. None.

Fracture. Streight, flaty; the laminae are undulated upon the surface.

Hardness. Easily scraped with a knife: but this degree of softness is probably owing to the influence of the weather, as the specimen now described was taken from the surface of the stratum.

Streak. Grey.

Smell. Emits a strong earthy smell when breathed on.

Cubical crystals of iron pyrites are dispersed through it; and these, by the escape of the sulphur, are converted into brown iron ore. It is worthy of remark, that the pyrites which occurs in the primary strata is much less liable to decomposition than that which we find in the secondary; and farther, that altho' we find pyrites very abundant in the primary strata, yet the combinations of the sulphuric acid with earths are rarely to be observed.

observed *. Mr Kirwan, in the second volume of his Mineralogy, explains to us the difference between those pyrites that effloresce and decompose quickly, and the others which decompose more slowly. He remarks, that those pyrites which effloresce spontaneously, contain iron in a metallic state; but the others which decompose more slowly, and by the separation of their sulphur, have the iron in the state of an oxyd.

CHLORITE SHISTUS.

SLATY CHLORITE, Kirwan's Mineralogy. *ARGILLA CHLORITES SHISTOSUS*, Werner.

Colour. Dark-green.

Internal Lustre. Little glancing.

Transparency. None.

Fracture. Slaty; lamellæ pretty easily separable.

Hardness. Yields easily to the knife.

Streak.

* Gypsum has been discovered mixed with mica in Mount St. Gothard; 44 J. de Physique. Pallas has observed gypsum associated with felspar in Siberia; 5 Nord. Beytrage. Sulphat of Barytes has been observed in gneifs in the mountains of Savoy, as mentioned by Werner. These are the few instances that are known.

Streak. Green.

Smell. Has a strong earthy smell, when breathed on.

Frequently grains and layers of quartz are to be observed mixed with the chlorite; and sometimes the quartz is penetrated with it, forming a fossil not unlike prase. Iron pyrites are sometimes intermixed with the chlorite, and, by their decomposition, colour the rock brown. Crystals of green hornblende are also to be observed intermixed with the chlorite; and according to the quantity of hornblende, the rock passes more or less to the state of hornblende rock.

FOLIATED CHLORITE.

BLATTRIGER CHLORITE, Werner, Esthner's Mineralogie, Emmerling's Mineralogie.

The colour is that of the common chlorite.

It is found not only massive, but also dispersed, and crystallized.

The crystals are in the form of a double conical pyramid, with truncated apices; and are to be observed also in the form of a cylinder, with a cone or conical pyramid upon each extremity.

The

The crystals are small, with little lustre on the outside, but strong glancing † internally.

Lustre. Intermediate between the greasy and mother of pearl.

Fracture. Foliated; but most commonly curved foliated.

Transparency. Semi-diaphanous; or such as to permit light to pass thro', but so little that objects cannot be distinguished.

Hardness. Not easily scratched with the nail, yet yielding easily to the knife.

Fragments. Tabular; feels a little fatty; and is not remarkably heavy.

It is found investing white-coloured quartz, but more commonly well crystallized in cavities of the quartz. I have only observed it in the island of Jura, among the strata of chlorite schistus, upon the road from Ardfin to the harbour of the Small Isles. According to Emmerling, it is a very rare fossil; as it has been observed in one other place only, that is, upon the mountain of St. Gothard, in Switzerland, where it is accompanied by crystals of adularia, reddish-brown schorl, and rock crystal.

The crystals are in the form of a double conical pyramid, terminated apices; and are to be observed also in the

form of a cylinder, with a cone or conical pyramid upon

† Stark glänzendi.

HORN-

HORNSTONE.

ACHATES PETROSILEX, Lin. *SILEX CORNEUS*, Wern. *NICO-*
MIA, Dr Walker. *CHERT*, Angl.

Colour. Pale brown; in some parts green, when intermixed
 with the magnesian rock in which it lies.

Lustre. None.

Transparency. Transmits a little light at the edges.

Fracture. Fine splintery.

Hardness. Strikes fire plentifully with steel.

Where it is in contact with the magnesian rock, it is much
 intermixed with it, has a green colour, and at length fairly
 passes into the talcaceous shistus of which the island is formed.
 Sometimes we find veins of crystallized calcareous spar traver-
 sing it.

TALCACEOUS SHISTUS.

LAPIS OLLARIS, Waller. *TALCUM OLLARIS*, Lin. *TALC SCHEI-
FER*, *VERHARTETER TALC*, Germanor. *TALCUM PROPRIUM
OLLARI*, Werner.

Colour. Dark-greenish black, or yellow.

Lustre. Nearly as shining as silk.

Transparency. Sometimes transmits a little light at the edges;
in other specimens, when it passes to ardesia, it is opaque.

Fracture. Shistose.

Hardness. Yields to the knife easily; but, as it passes to the
state of argillite, becomes harder.

Streak. Grey.

This rock is to be observed passing, upon the one hand, to
the chlorite slate, and, on the other, to ardesia. It is found in
different parts of the islands of Isla and Jura, as has been men-
tioned in the preceding chapter.

LIME-

LIMESTONE.

Colour. Dark blue.

Lustre. Very weak, principally from a few shining particles dispersed through it.

Transparency. None.

Fracture. Even, fine splintery.

Hardness. Yields with some difficulty to the knife.

Streak. Grey.

It forms the central part of the island of Isla, and contains no petrifications; which renders it probable that it is of primitive formation. It may be objected to this, that all primitive limestones have a scaly or granular grain. We cannot doubt that, in general, this observation is perfectly correct; but it seems liable to exceptions: as Mr Kirwan, in his Geological Essays, mentions, upon the authority of the Helvetic Magazine, that the mountains of Wetterhorn, Wellhorn and Burghorn are formed of primitive limestone having a splintery fracture; and I shall afterwards mention primitive limestone, or marble, with a splintery fracture, as occurring in the Hebrides. Mr Kirwan further mentions, that, as some traces

of muriatic acid are to be found in secondary limestone, and none in the primary, this may serve as a good test for distinguishing them. I have not, however, made any experiment, with this view, upon the Isla limestone.

COMPACT MARL—STONE MARL.

VERHARTETER MERGEL, Germanor. *CALCAREUS MARGA INDURATA*, Werner.

Colour. Yellow, or yellowish white.

Lustre. None.

Transparency. None; but, when much penetrated with filiceous matter, transmits a little light at the edges.

Fracture. Fine splintery.

Hardness. Yields with difficulty to the knife; and, when penetrated with filiceous particles, scarcely yields to the knife.

Is slowly acted upon by acids, and feels heavy.

It is used for the purposes of agriculture, but it requires several years before it falls.

MELAN-

MELANTERIA, Pliny—BLACK CHALK.

SHISTUS scriptura atra, ater inquinans, Linn. *ARGILLA NIGRICA*, Werner. *SHISTUS NIGRICA*, Waller. *MELANTERIA*, Dr Walker.

Colour. Bluish black.

Lustre. Longitudinal fracture extremely little glancing, and the cross fracture none.

Fracture. Longitudinal fracture, curved flaty; but the cross, fine earthy.

Streak. Little glancing. Colours black, but without the lustre of plumbago.

Hardness. Pretty easily scratched with a knife.

This fossil occurs often in the neighbourhood of aluminous shistus; and is always found, disposed in beds, in the primitive mountains, particularly in ardesia. As it writes upon paper, and has a bluish-black colour, it has often deceived the uninformed, who have imagined they have discovered black lead: the difference of lustre, and other characters, however, sufficiently distinguish them. It has also been taken for coal, or reckoned a proof of the vicinity of coal strata. Thus, Dr Reufs,

Reufs †, in travelling through Bohemia, tells us, that he observed a shaft sunk several fathoms through ardesia, and, upon enquiry, he found it was in search of coal. This coal, however, upon examination, he found to be a species of aluminous slate, very nearly resembling black chalk. This should serve as a strong caution against making trials, without having first examined carefully the rocks which we think indicate the presence of coal; and farther, whenever any coal-like substance (which was the case here) is observed only among primitive rocks, it should excite a still stronger doubt, when we recollect that coal has never yet been detected, nor probably ever will, in any quantity, in primitive mountains.

† Mineralogische Geographie von Boehmen, Zweiter band, § 202.

SEIL, EASDALE AND OBAN.

C H A P. XII.

*Voyage from JURA to the Slate Islands of SEIL and EASDALE;
thence to OBAN and the Island of MULL.*

HAVING found it very inconvenient to examine the west and northern parts of Jura, Mr Macnicol, the minister of the island, (to whose kindness we were much indebted,) procured a boat, and we sailed from the harbour of the Small Isles to the island of Seil, a distance of about 30 miles. As the weather was charming, we kept close along the shore of Jura, which gave us an opportunity of landing upon different parts of the island. Having reached the northern extremity, the wind increased a little; soon after, we heard the great whirlpool, the Coryvrekan, raging, in the sound between Jura and the island of Scarba.

We

We now passed the rugged island of Scarba, which is apparently composed of micaceous schistus traversed by basaltic veins; next, the island of Luing, said to afford much ardesia; soon after, the small isle of Balinahuia, where there is an extensive quarry of ardesia; and, at some distance, we observed the island of Garveloch, where there is a considerable quarry of schistose marble*, first discovered, many years ago, by Dr Walker. After much opposition from an extremely violent tide, we at length landed upon the island of

S E I L.

THIS island, about 3 miles long, and 2 miles broad, is separated from the island of Easdale by a strait a few hundred feet broad, and from the mainland by a narrow pass over which a bridge has been thrown. The island is in general flat, yet not without hills, from the highest of which we have a pleasant view, of the ma-

* This marble rises in flags of a considerable size, some 3 feet by 2, and even 4 feet by 3; takes a good polish; and is of a white or grey colour, and is sometimes clouded; and has a fine grain.

ny small isles scattered over the ocean, with the distant mountains of Mull and Jura.

The greater part of the island is composed of rocks of primitive formation, and these are micaceous schistus and ardesia. Basaltic veins are also very frequent, traversing both kinds of strata; and, where the stratified matter is washed away, or has fallen down by decomposition, the perpendicular veins appear often like basaltic crags, and, at first sight, may be taken for strata. Considerable veins of quartz are also to be observed traversing the primary strata upon the south and east shores of the island; and, near to the southern extremity, I observed a vein of quartz which contained a quantity of iron pyrites, but apparently too small to be of any importance.

Besides these primary strata, I observed, upon several parts of the island, small portions of the transition (uebergangsgebürge) and flötz rocks (flötzgebürge). Near to Mr Campbell's house, I observed the ardesia covered by grauwacken, and both apparently traversed with the same basalt vein; which leads us to suppose that they were formed at the same time; and, in support of this, I may mention, that German mineralogists have observed these rocks to alternate*. Upon the side of the

B b

island

* Emmerling, Band. 3. § 105.

island opposite to Easdale, we have an appearance of flötz strata. Immediately upon the shore, I observed red-coloured argillaceous sandstone, stratified with sandstone breccia and basalt, and the whole traversed with basaltic veins. There are also quarries of *ardesia tegularis* in some parts of the island. But the principal attention of the proprietors is turned to the island of Easdale, where the slate has hitherto been found in great quantity.

E A S D A L E.

THIS island is about half a mile long, and of the same breadth, and is celebrated for its having afforded the best and greatest quantity of *ardesia tegularis*, of any part, of equal extent, in Great Britain. A very considerable portion of the island is composed of *ardesia tegularis*, and this is traversed by basalt veins. The *ardesia*, where in contact with the basalt, is useless, being shivery, and breaking into small pieces, unfit for the making of slates: it is also equally bad, where veins of quartz or limestone occur.

The

The island is now cut very low, excepting a small portion at the south end; and levels have been made out to the sea, to carry off the rain water. As the greater part of the island is now upon a level with the sea, it is plain that the raising of slates must be abandoned, or continue to be worked at a considerable expence by means of machinery; which would probably be a bad plan, when we consider the extent and excellence of the rival quarries at Ballyhulish ‡. The most judicious arrangement would certainly be, to open more extensive quarries in the neighbouring isles of Luing and Seil, where, in all probability, after the ground is properly cleared, good slates may be found.

The ardesia in this island was first quarried about one hundred years ago; but was for a long time of little importance, as sandstone flag and tiles were generally used for roofing houses. As the use of slates became more prevalent, the quarries were enlarged; and the present managers having obtained a very favourable lease, these quarries have been wrought to so great an extent, that 5,000,000 slates are annually shipped from this island. The number of workmen is at present about 300; and

B b 2

they

‡ The quarries at Ballyhulish employ about 200 men; and the slates are sent to Leith, Clyde, England, Ireland, and America.

they are divided into quarriers and day labourers. The quarriers are paid annually at a certain rate for every thousand flates : from 10d. to 15d. I believe, as their work has been attended with more or less difficulty. The day labourers are employed at the company's expence in opening new quarries, and have from 10d. to 1s. a day.

O B A N.

AS the weather continued very pleasant, we preferred going to Oban by sea, in place of the circuitous rout by land. Having procured a boat, we left Seil, with a fine breeze ; our voyage was agreeable, with scenery often striking ; on one hand, was the lofty coast of Mull, extending from Loch Bay to Crogan, all apparently basaltic ; on the other, the mainland rising into small hills, also with a basaltic aspect. Having passed the isle of Kerrera, which lies across the bay of Oban ; in a short time afterwards, we landed at the village. The bay of Oban is of a semicircular form ; is from 12 to 14 fathom deep, with good anchoring ground, and will contain 500 sail

of

of merchant ships. The village is pleasantly situated at the upper part of the bay, a station excellently adapted for the fishing. The decline of this branch of trade, has indeed been unfavourable to the rise of Oban; but it is, notwithstanding, the most considerable village on this part of the coast, containing about 586 inhabitants. It is to the exertions of the two brothers, the Messrs. Stevensons, who settled here in 1778, that Oban is chiefly indebted for its present flourishing condition.

As we were anxious to proceed on our journey through the islands, well knowing the variable state of the weather in these highland countries; we took but a glance of the rocks in the neighbourhood of Oban. The strata immediately upon the shore, on both sides of the town, are formed of dark blue coloured argillaceous schistus; immediately above this, I observed in some places basalt, or basalt porphyry. As we approach Dunolly castle, which forms the extreme point of land upon one side of the bay, vast rocks of breccia appear; and these continue all the way to Dunstaffnage castle*. Both these castles

* At Boregonium, which is a few miles from Dunstaffnage, there are, according to Dr. Garnet, undoubted volcanic appearances. Dr Walker informs me, that the pumice, which Dr. Garnet mentions, is the scoriae from the iron furnaces, which were worked at that place by our ancestors.

ties are built upon rocks of breccia, which is composed of variously shaped pieces of granite, micaceous shistus, and sandstone, connected by an arenaceous breccia. Upon different parts of the coast, and in the interior of the country, this breccia seems to lye upon a red coloured argillaceous sandstone. From Oban, the country becomes gradually higher as we approach the great mountain of Cruachan; and the strata also change. If we walk by the Inveraray road, we observe wacken, and sometimes basalt covering the sandstone; and in many places great rounded masses of granite, which formerly constituted part of the breccia, are to be seen scattered about. These sandstone and basalt strata, probably continue until ardesia and micaceous shistus, which form the lower region of Cruachan, make their appearance; and this is succeeded by the granite, which rises through it, and continues to the top of the mountain*.

Mr. St. Fond has given us a chapter upon the lithology of Oban, in his travels through Scotland; but he has here, as usual, intermixed his theoretical speculations with the descriptions of the strata. He denominates the blue argillaceous shistus

* I owe this information, with regard to Cruachan, to my friend Mr. Cadell.

shiftus of Oban, a limestone; this, he says, is an aquatic production; but the basalt, he imagines to have been superinduced in a melted state under water, which prevented the limestone from being altered; and further, he describes the breccia as a volcanic matter, which has been thrown up in a similar manner with those volcanic eruptions “in which water heated to the highest degree of ebullition, enters into concurrence with fire, and the different elastic emanations generated by subterraneous combustion.” I must confess my inability to comprehend this explanation; at any rate, it is now useless to attempt supporting this part of the volcanic theory, as it has been demonstrably refuted by Mr Kirwan, in his paper on basalt.

VOYAGE TO MULL.

HAVING arranged every thing for the continuance of our journey, we set sail for the island of Mull, which is about 15 miles from Oban. In our way, passed near to the isle of Kerrera, of which Faujas gives the following account. “A part of this island is volcanic; on the coast fronting Mull, there are

“ are collections of compact lavas in masses, and in large currents. This basaltic lava appears sometimes in the form of prisms, which are not very regular; at least in the places I had an opportunity of examining. I also found some rocks of micaceous schistus of a whitish colour, and others which were greenish, with a porous texture. These schistus, or gneiss, are composed of quartz, feldspar, and small scales of mica.

“ Near the rock of micaceous schistus, there is found common slate of a deep grey colour, approaching to black; the beds of which are almost even with the ground; quarries might easily be opened here with great advantage to the country. They would even become an object of commerce. Among the slate, there are found some brilliant pyrites, the crystallizations of which are cubical †.”

We next passed the island of Lismore, which is about nine miles long, but very narrow: it is according to Williams, composed entirely of limestone, traversed with basaltic veins. Dr. Mitchell supposes that the limestone belongs to the transition rocks.

† Travels through Scotland, &c.

rocks (uebergangsgebürge). From the greater part of the island being formed of limestone, at the same time well sheltered, it is rendered one of the most productive spots in the Highlands. After a short voyage, we came close in with the coast of Mull, but on account of the tide, we were obliged to pull along the shore for some miles, which gave me an opportunity of examining the shore, until we landed on the coast below Achinacraig.

MULL.

C c

M U L L.

C H A P. XIII.

Outline of the MINERALOGY of the Island of MULL.

THIS island is about 22 miles long, and 16 miles broad. It is reckoned by some writers to be the Maleos of Ptolemy *; and Cambden is of opinion, that it is the Mille of Pliny †. On the north, it is bounded by Ardnamurchan; on the east, by the rugged sterile looking mountains of Morven, and the isle of Lismore; to the south, are the isles Jura, Scarba, and Slate isles; and on the west, I-kolmkill, Staffa, Coll, and Tiree.

The coast of this island is much diversified in its appearance; in many places we observe a great extent of steep and bold
rocky

* Campbell's Political Survey, vol. I. p. 599.

† Britannia, p. 848.

rocky shores, forming tremendous precipices; particularly upon the south shore near Loch Buy. Often the shores are low, but still rocky and dangerous; seldom is there any sandy beach, the coast being generally covered by the immense masses that have fallen from the neighbouring cliffs. It is low, however, towards the S. W. extremity which is called the parish of Ross.

The island is very mountainous, and some of the mountains rise to a considerable height; particularly Ben-More, which is reckoned the highest in the island. It is much intersected upon the west side, where there are two considerable lochs or arms of the sea, called Loch Skriddan, and the other Loch-na-gaul.

MINERALOGY. Achnacraig, where we landed from Oban, is situated at a little distance from the sea shore, with some considerable flats near it; and these being cultivated, and in some places wooded, enliven the scene considerably. The rocks are in general basalt and wacken, which are in many places traversed with basaltic veins. The occurrence of veins of basalt crossing a similar rock, seems to be very rare; as I am well informed, that foreign mineralogists, have never observed such appearances. Mr Faujas St. Fond, in describing

this part of the island, seems to have been much struck with one of these veins, which he compares to a circus; and has given a long detail of the way in which it may have been formed. This was all very unnecessary, as this vein does not differ from many others to be observed in the island; and the idea which Mr St. Fond raises of its magnificence, is far stretched—it is trifling when compared with the grand appearances upon the coasts of Isla and Jura. As we advance towards Loch Speleve, the cliffs upon the shore do not increase much in height; but there are land cliffs behind them considerably higher. The rocks are almost entirely of basalt and wacken, all the way to the loch, as also the hills in the neighbourhood. About half a mile from Achnacraig, I observed a stratum of blue coloured limestone, covered with calcareous sandstone; but these strata are visible only for about 80 feet, when they are lost under the basalt. This limestone contains in it belemnites, and is therefore to be reckoned with the transition rocks; and is what Mr Kirwan considers as the most ancient of the secondary strata*.

As there is a good road, along the shore of the island, from Achnacraig to Tobermory, we preferred it to coasting by sea.

Having

* Geological Essays, p. 226.

Having left Achnacraig, we passed, for about a mile, through little wooded glens, which are extremely pleasant, particularly in a country where wood is truly a rarity. The strata still continued basaltic, excepting at one place where I observed a stratum of blue-coloured limestone cropping thro' the soil. As we journeyed along the shore at the bottom of the high hills which bound it, I judged it necessary to examine some of them to their summits; that I might obtain more distinct information of their nature, and have an opportunity of surveying the neighbouring country. The day being fine, we began to ascend a high hill, about two miles from Achnacraig. The ascent was very steep, until we reached an extensive plain several hundred feet above the level of the sea. The strata, to this height, were basalt and greenstone, and both frequently traversed with basaltic veins. The greenstone, even at a considerable distance, has a singular scorified-like aspect, from the felspar having decayed, and the remaining hornblende, resembling a dark green, or blackish cellular mass, not unlike the scoria of an iron furnace. The plain was covered, to its whole extent, with loose stones of an iron-brown colour. Hardly a trace of vegetation could be seen; and the deep silence of this desert was disturbed only by the rushing of the cold piercing wind across the mountain. The loose masses of rock just mentioned, I found to be of breccia, which is composed of variously

riously shaped masses of quartz, earthy felspar, hornstone, and granite, connected by a basalt or wacken? basis †. It is probably of the nature of basalt tuff; which, according to German mineralogists, is a rock with a basalt or wacken basis, having, immersed, fragments of other rocks, as granite, quartz, &c. We now walked towards the summit of the mountain, which we reached, after having passed over a succession of smaller plains, or platforms, separated from each other by steep basaltic craigs. The summit is composed entirely of basalt, which contains much hornblende; and this rock has the property of reversing the compass at a considerable distance, and even in detached pieces. From this elevated situation we had a fine view of the island. Towards Tobermory the mountains appear to become gradually lower; but, upon the west side, a tremendous groupe of variously-shaped mountains appears before us, and among them Ben-more rises with much dignity. The glens, which we observed run from the mountain, are of great depth, very steep, and apparently composed of strata of basalt and greenstone. These strata, however, run in a direction contrary to that of the vallies, which intimate that the land has

† I am obliged to mark this doubtful, as I unluckily lost the specimens, which would have enabled me to determine the nature of the basis.

has sunk down, as we have already explained in our speculations upon the formation of the bed of the Clyde. We now descended from the mountain, but by a different route from that which we followed in ascending; and although it was fatiguing and difficult, it afforded us an opportunity of observing the basalt and greenstone alternating with each other, and elevated nearly to an angle of 45° .

We now continued our journey along the Tobermory road, with hills upon one hand, but in a short time the land on the other became low, stretching out towards the sound of Mull, to a point on which is situated Duart Castle. The hills, as also the hills near the shore, are still basaltic; but we were informed that there is, at the castle, a great stratum of limestone, which affords *cornua ammonis* and shells. As we approached Achnacrosh, we observed, upon the shore, strata of argillaceous sandstone, with interspersed bituminous and coaly matter, as is usually the case with sandstone in coal countries; and, at a little distance, a rock, which seems to be analogous to greenstone, of which a particular description is given in the following chapter.

From this to Arros the shores are low, but the hills rise to a considerable height; and both are formed of basalt, greenstone, and

and wacken, which I sometimes observed traversed with basaltic veins. The basalt, but more particularly the wacken, contains zeolite, which is either compact, fibrous, or crystallized. I regretted extremely that I had not an opportunity of examining this part of the country more particularly, as there can be no doubt but that it would afford much curious information with regard to the rocks of trap formation. I have however to offer as an apology, (if such a thing is becoming,) that, in travelling over all that track of country, we were envelopped in thick clouds and pouring rain; so that the few observations as to the nature of the hills, were made by examining the debris in the ravines, or were now and then assisted by the partial dispersion of the clouds. I may now also remark, that, in travelling these countries with a view to the particular examination of their mineralogy, it will be absolutely necessary for the traveller to carry along with him a tent, and other conveniences, so that he may encamp among the mountains, and examine them leisurely, and with that scrupulous accuracy which the importance of the subject requires.

At Arros there is a small colonade of basalt, upon which there are still the remains of an old castle, once inhabited by Macdonald prince of the Isles. In the bed of the river of Arros, (a small stream of water which comes from the neighbouring
basaltic

basaltic hills,) I observed numerous blocks of granite, similar to those upon the hill near Achnacraig. These blocks seem to be derived from a basalt tuff similar to that observed near Achnacraig; and it is probable that such a rock may be discovered in the neighbouring hills. It will be an object worthy the attention of future travellers, to ascertain, whether this basalt tuff merely covers the basalt, as has been observed by Reufs in the mountains of Bohemia, or alternates, as is the case with the basalt tuff in the isle of Canna, and in other parts of Scotland. It matters not in which of these situations it be found: it is still to be considered as a secondary rock, and, like these, to have been deposited from an aqueous fluid. Probably some may think that these masses have been separated from the decomposing basalt itself, as it sometimes contains pieces of granite. This, however, is an appearance so rarely to be observed in this island, that I can hardly imagine the granite blocks to be derived from that source.

Professors St. Fond has speculated upon this subject, as he observed similar appearances in different parts of the island. For the information of my readers, I will extract the following passage from his Travels. "These lumps of granite (says he) may have been ejected from granite quarries, which perhaps existed at great depths

“ depths under these ancient volcanoes, by the explosions which
“ took place at that epoch, when extensive combustions wasted
“ these countries, and formed groups of islands, which seem
“ to have the same origin.

“ It is, besides, within the verge of possibility, that those
“ parts of the mountains where they are now found were not,
“ at that period, elevated summits, but rather formed part of
“ the bottom of the sea, and that these granite blocks were
“ rolled from a distance by the currents. It is possible that
“ circumstances of subterraneous explosion, equally terrible
“ with those which formed the isle of Santorini in the Archi-
“ pelago, or Montenove in Italy, may have raised up the bot-
“ tom of the sea into volcanic peaks; or, if it should appear
“ more plausible to some, we may refer to a period when
“ mountains still higher were covered by the sea: a fact, which
“ cannot be doubted, since marine bodies are found in great
“ abundance in beds of limestone, or clay, situated on the Alps
“ or Appenines, at a height three or four times greater.”

At Arros, we changed our route; and in place of going on
to Tobermory, we took our course across the island to Luggan
Ulva. The road, which is but indifferent, leads us among
hills of no considerable height, to the plain of Knock, situ-
ated

ated at the head of Loch-na-gaul. The hills are composed of strata, of basalt, and wacken; which are sometimes traversed with basaltic veins. The loch, which is of considerable extent, is bounded upon one side by the mountain of Ben-more, with other neighbouring hills, that extend towards the sea shore, forming lofty crags, not unlike those of Salisbury Hill near Edinburgh; on the opposite side, are the hills that bound the road which leads towards Luggan Ulva. Ben-more, which is the highest mountain in the island, is of considerable magnitude; and Mr St. Fond remarks that it has much the appearance of the famous volcanic mountain Vesuvius. We did not ascend this mountain, so that I cannot give any account of the rocks of which it is composed; but I have had the opportunity of examining specimens brought from it by Mr. Caddel. It would seem from these, that it does not differ from the other parts of the island which I have already described, being composed of basalt and greenstone; even to its very summit. This agrees pretty nearly with the observations of Mr. St. Fond, who tells us, that it is composed of lava; that is basalt. We pursued our journey along the opposite side of the loch, which led us to Luggan Ulva; I found little variety of rock; the basalt and wacken strata traversed with basaltic veins, still continuing

Did 2 ing

ing. The wacken, however, affords many beautiful specimens of zeolite, and also a rarer fossil, the prehnite.

Nearly opposite to Luggan Ulva, lies the small island of Ulva, which is evidently composed of the same rocks; and farther distant, is the isle of Geometra, which is also basaltic.

As soon as the weather, which had been for some time tempestuous, became moderate, we crossed at the mouth of Loch-na-gaul, and landed immediately under the high cliffs, which we had seen from the head of the loch. We now walked along a considerable extent of shore, which is bounded by lofty crags, composed of basalt and wacken strata, and both traversed by basaltic veins, which run in very different directions. Immediately upon the shore, I observed strata of argillaceous sandstone, and sandstone breccia; and we were told, that both coal and lead had been discovered in several places in the neighbourhood. About 200 feet above the level of the sea, on the tract which takes us across the mountains to Loch Skriddan, our attention was arrested by the appearance of a curious species of breccia. It is composed of fragments of quartz, micaceous shistus, compact limestone containing flint, and the whole cemented by an arenaceous basis; sometimes it has a calcareous basis, when it has a yellow colour, owing

to

to a decomposition of the limestone. Below the breccia we observed a compact micaceous shistus. In going higher up, we had a more distinct view of the stratification; which is as follows: 1. Micaceous shistus. 2. Breccia covering the micaceous shistus. 3. Sandstone, more or less of the nature of breccia, covering the breccia. 4. And higher up the mountain appeared the basalt; but we could not determine correctly its situation with regard to the strata just mentioned. The appearance of micaceous shistus in a basaltic country, is a singular phenomenon, well deserving the attention of future travellers.

From this, we continued our journey in the direction of the great Bourg head, (a lofty promontory at the entrance of Loch-Skriddan,) over which we crossed, and descended to the shore of Lochleven or Skriddan. The strata in this tract are still basalt and wacken; and both are traversed with basalt or wacken veins; and contain much zeolite. I accidentally discovered a piece of black pitchstone porphyry, similar to that which is found in Glencloy, in the island of Arran. This Loch, which is pretty extensive, is bounded on both sides by basaltic hills; and at its upper extremity, there is a grand groupe of basaltic hills that congregate nearly to the opposite side of the island, about Loch Spelve. We crossed the loch

near

near its mouth, and walked along the shore, which is low and basaltic, until we approach Artown, when it juts out into a promontory, which presents several very beautiful ranges of basaltic columns. Upon the N. E. side of the promontory, we observed, immediately upon the shore, a stratum of coal, which has for its roof a mass of imperfectly shaped basaltic pillars; and its floor is also basalt. The stratum is about 12 inches thick; and sometimes interposed between it and the basalt there is a thin layer of blaes (shistose clay), which is mixed with the coal, and deteriorates its quality. We could only observe the stratum running for a short way, as the sea has thrown up debris along the bottom of the rocks, where the coal is situated: yet we were told, that it is to be seen cropping out upon other parts of the coast. As the country is low in the neighbourhood of the coal; it is certainly worthy the attention of the proprietors, to endeavour by trials skilfully conducted, to know how far this stratum extends; and whether other strata exist near to it. It has been objected to this, that if any trials should be made, it would merely satisfy curiosity, without the probability of success; as it is imagined that basaltic rocks are very unfavourable to coal. We cannot deny the fact, that coal is seldom so regular under basalt, as under sandstone; yet, in a country where the best part of the year is wasted in the operations of cutting and drying peat, there

there can be no doubt, that the discovery of a bed of coal, (although it should not be so extensive as those in the sandstone countries), would be of the highest importance.

We are further encouraged to make regular trials, when we know that in other parts, considerable beds of coal have been found among similar rocks. Thus at Borrowstounness, according to Mr. Williams, we find thick strata of basalt interposed between beds of coal, which are worked to a great extent: and in the Bathgate hills, coal and basalt alternate with each other*. In Bohemia, according to Reufs, coals inlaid in basalt are worked †; in the Faroe islands, coal is found in strata among basalt ‡: at Meissen, in Hesse, a bed of coal from 6 to 90 feet, is found covered with basalt, to the height of 600 feet ||.

Mr Mills, in the paper which I have already mentioned, when describing Ila and Jura, gives an account of a remarkable appearance near Artown, which unluckily I had not an opportunity of viewing. As it will be interesting for future travellers

* Williams's Mineral Kingdom, vol. 1. p. 70.

† Mineralogische Geographie von Boehmen.

‡ Haidinger Gebergsarten.

|| Bergm. Journ. 1792, 319, and Kirwan Geological Essays, p. 311.

travellers, I shall here insert his description, and make a few observations on it.—“ About a quarter of a mile from the spot where the bearings were taken, is a deep glen, running N.N.E. to the sea. It is about 30 yards in length, and 20 in breadth. The strata are disposed in the following manner: The uppermost is 10 yards of lava, with horizontal divisions, and vertical joints, taking the form of rude pillars. Under this, is a horizontal bed of perfectly vitrified substance, which appears to have been a shale, and is from 1 to 2 inches in thickness. Beneath this, is about three yards of siliceous gravelly concrete; below which, are horizontal beds of indurated marle of various thickness, from 6 to 12 inches. The whole of these beds taken together, are about four yards; and there is a large fissure in them, on the west side of the glen. Lastly, are 10 yards of rude lava, containing specks of quartz, and mica unaltered; pieces, apparently of granite; and in some, nodules of calcined chert. The whole is incumbent on regular basalt pillars of various dimensions, from 18 to 6 inches in diameter, varying in their number of sides; some having 5, some 6, others 7, &c.” This gentleman, by denominating his fossils upon theoretical principles, has thrown a considerable degree of obscurity over his description. To me, the following appears to be the true account:—

Lava

Lava.—This is probably basalt: for he appears to use this term in different parts of his memoir, as expressive of all kinds of basalt.

Vitrified substance.—This is certainly the same with the black pitchstone which we have already observed upon the opposite side of Loch Skriddan; and which we were told had been found near Bunefan and at Bennenoch.

Siliceous gravelly concrete.—Probably a coarse sandstone? If this supposition be correct, it is another example of pitchstone being contained between sandstone and a rock of trapp formation, similar to that I suspected in the island of Arran.

Indurated marle.—This is probably the same with the limestone, which contains flint upon the coast between Loch-na-gaul, and Loch-Skriddan.

Calcined chert.—This is likely hornstone; which, however, is a rare occurrence in basalt. Emmerling. B. 3. § 187.

We now left Artown, and walked on to Bunefan; the country still continued to be formed of basalt, containing many

E. e

beautiful

beautiful specimens of zeolite passing to chalcedony, and also prehnite. Near to this place, there is a little river which marks the termination of the secondary, and the beginning of the primary strata. Upon the east bank, I observed the basalt; but upon the west, the strata are of micaceous shistus. I endeavoured, as far as my short time would allow me, to discover the junction of the strata, but was not so fortunate as to observe them in actual contact: yet, I think it not improbable, that the basalt lies upon the micaceous shistus. This supposition, may to some appear to invalidate the observation I have made in a former part of the work, viz. that basalt is never found among primary strata. This is by no means the case; for here, the basalt forms a great extent of country; and in some places, as at Artown, it contains coal; so that, although it lies on micaceous shistus, without any intervening breccia, it cannot be considered as primitive. It appears to me a good mode of ascertaining whether a rock be primary or secondary, to examine whether it alternates with strata decidedly primitive; and whether, at its junction with the primary strata, it seems to be in part intermixed, and partly assuming the nature of these strata; thus intimating that they have been deposited at the same time.

The

The micaceous schistus extends quite across this part of the island; and continues for about a mile after we leave Bunefan, in going to the southern extremity of the island. In this extent it is somewhat varied in its appearance, being more or less compact, sometimes containing garnets, and traversed with basaltic veins. In other places, as upon the side of Loch-Artineg, I observed it alternating with strata of quartz, from one to three feet thick, and which broke into thin layers.

To the micaceous schistus succeeds beautiful red granite, which continues to the extremity of the island, forming low, round-shaped hills. This part of the island, which is called Rofs, is low, intersected with small lakes, and diversified with natural wood. The shores are low, but rugged and broken; and in some places we observed large empty fissures, which appear to have been formerly filled, either with an earthy matter, as basalt, or with a metallic ore. The granite appears to be disposed in beds, as we have already mentioned to be the case in Arran. Dr Walker, many years ago, observed this disposition of the granite, not only in Mull, but in many other parts of Scotland; which is a further and decisive proof of the fallacy of La Metherie's observations. The granite sometimes splits into rhombs, and what is more uncommon, into columns, not unlike basalt. This appearance of columnar granite is,

I believe, rather a rare occurrence; at least I do not find it mentioned but by Reufs, who discovered beds of granite split into columns, not unlike basalt *. In many places I observed basaltic veins traversing the granite; and these are of various sizes, and run in very different directions. Upon the side of Loch-Artineg I observed a vein running through the granite, visible for nearly a mile, and often branching out in different directions. Sometimes I observed pieces of granite included in the basalt veins; and in one instance I observed the granite, which bounds the side of the vein, mixed with the basalt.

The fourth side of Ross continues to be formed of granite and micaceous schistus, until we come upon a line with Bunefan, when the basaltic rock commences. From this to Loth-Buy the country and coast are principally formed of basalt and wacken, excepting at Gribun, where sandstone and limestone are to be observed, and at Carseg, where there are considerable appearances of limestone. The rocks upon this coast, in some places, rise to a most tremendous height, particularly at Innimore, where we observe many ranges of basaltic columns towering

* Mineralogische Geographie von Boehmen, Erster band, § 120. I think that Saussure, somewhere in his Travels, mentions a similar appearance.

towering above each other with vast magnificence. This stupendous scene is rendered doubly interesting when its rocks are obscured by a tempest: the dashing of the furious ocean below, and the fall of vast cascades from the rugged summits, seen dimly thro' the clouds, present a scene of uncommon sublimity.

There are several appearances of coal upon this coast, but the most remarkable is that upon the hill called Beinan-ini. This hill is composed of horizontal strata of basalt and wacken, which alternate, and rise to the top of the hill like great natural terraces. The coal appears in the bed of a rivulet upon the side of the mountain; is about three feet thick, and is immediately covered by basalt. It is one of the greatest strata of coal that has yet been discovered in the Western Islands, and consequently is worthy of particular attention. Several trials have been made with a view to the working of it; but of a nature so trifling, that they can deserve notice only as showing how little the importance of the subject has been understood. Sir David Murray of Stanhope, so far as we can learn, was the first gentleman who seems to have been aware of its consequence; for, about the beginning of the last century, he purchased this hill solely on account of the coal which it contains. He proposed to open the stratum in a very extensive manner,
and

and to work it until he should be satisfied whether it was practicable to continue it to advantage. This scheme was unfortunately frustrated by a failure in his affairs, which made him stop working a short time after he had begun. Since that period, the property has come into the possession of Sir James Riddell of Ardnamurchan, who seemed inclined to continue the work of his predecessor; but the business appears to have been committed to persons who were satisfied with making very superficial and unsatisfactory trials. This is much to be regretted, when we consider, that the establishment of coal-works, in so central a spot of the Hebrides, would not only be a great comfort to the inhabitants of the islands, where peat is scanty, and not to be procured without difficulty, but would make all the operations of the farmer to go on with new life, and would, in every way, contribute much to the improvement of the Western Islands. It is therefore worthy of the public spirit of the highland proprietors, to form a general subscription, so as to enable them to determine the question, whether the coal of Mull can be worked so as to be advantageous to the inhabitants of the west coast of Scotland and the Hebrides.

Having spent a few days in Ross, which gave us an opportunity of examining I-colum-kill, we walked again to Loch-Skriddan,

Skriddan, where we took a boat, and rowed along the lofty coast to Luggan-Ulva. In our way we passed the small island of Inch-Kenneth, remarkable not for its variety of fossils, as it is composed of red-coloured sandstone and limestone? but for the interesting account which Dr Johnson has given of the happy family of Sir Allan Maclean.

We now walked from Luggan-Ulva to Torloisk, the seat of the late worthy Mr Maclean. The shore is rugged; but the country is in several places considerably cultivated, particularly near Torloisk. The rocks, all the way, are of basalt and wacke; and both contain beautiful specimens of zeolite, which are generally fibrous, and sometimes appear passing to chalcodony. I observed, in some places, a red-coloured wacke alternating with the basalt. I also remarked blocks of granite similar to that we observed at Arros.

From Torloisk to the northern extremity of the island, the same basaltic rock continues; and, so far as I could judge, the whole of the coast towards Tobermory is of the same nature.

GENERAL

GENERAL OBSERVATION. From this rapid and imperfect outline, it appears, that a great portion of this island is composed of rocks of trap formation, and that they even form many of the high hills. The primary strata, upon the other hand, form a very small part; being confined (as far as my experience goes) to the parish of Ross, and the small patch upon the shore between Luggan-Ulva and Loch-Skriddan.

MULL.

M U L L.

CHAP. XIV.
Description of the FOSSILS mentioned in the preceding Chapter.

IT may appear unnecessary again to introduce an account of the ardesia tegularis, as I have described it in Arran and Jura. The description which now follows, however, is that of one of the most celebrated flats in Britain, and therefore it should not be omitted.

ARDESIA TEGULARIS—from *Easdale*.

Colour. Dark blue.

Lustre. Little shining.

Transparency. None.

Fracture. Perfectly flaty.

F f

Fragments.

Fragments. Tabular.

Hardness. Yields pretty easily to the knife.

Streak. Of a lighter colour than the slate itself; and the powder does not feel greasy.

Adhesion. Does not adhere to the tongue.

Smell. Pretty strong earthy smell when breathed on.

This species differs from that of Bute, in containing less magnesia, and being more durable. It frequently also contains cubical crystals of pyrites, and these long resist decomposition.

GRAUWACKE, German—*Island of Seil.*

RUBBLE STONE, Kirwan's Mineralogy.

This species is composed of fragments of ardenia and quartz, with scales of mica, or talc, connected by a reddish argillaceous matter. This genus of rock was for some time imagined to be peculiar to the Hartz (the great mining country belonging to the Elector of Hanover), but later investigators have observed it in other parts of the continent of Europe. We have much information concerning it in Lazius's observations upon the Hartz.

LIME

LIMESTONE—*Achnacraig*.

Colour. Dark blue.

Lustre. A degree of lustre owing to dispersed foliæ.

Transparency. None.

Hardness. Difficultly scraped with the knife.

Fracture. Earthy; sometimes approaching splintery.

Has pyrites dispersed thro' it; and sometimes I discovered it to contain Belemnites. By decomposition it acquires a yellowish colour, and this is much aided by the presence of the iron pyrites.

GREENSTONE?—*Achnacrosh*.

Colour. Whitish, from the great proportion of felspar?

Lustre. None.

Transparency. None.

Hardness. Gives fire pretty freely with steel.

Fracture. Earthy.

This rock appears to consist principally of a whitish-coloured matter, which is probably of the nature of compact felspar; and, intermixed with it, I discovered small portions of a green-coloured substance resembling hornblende, with a few interspersed crystals of common felspar and iron pyrites. It acquires a brownish-white tégmen by decomposition.

GREENSTONE—Hill near Achnacraig.

GRUNSTEIN, German. *SAXUM FERREUM*, Waller. *SAXUM GRANDÆVUM*, Linn.

The greenstone found upon this hill is composed usually of equal portions of white-coloured felspar and dark-green hornblende. I also observed specimens where the hornblende forms the greater part of the stone, and the felspar imbedded in it as a basis. In others, the felspar and hornblende are so intimately combined together, that it is only by the decomposition of the stone that we discover its compound nature.

HORN-

HORNSTONE—*Hill near Achnacraig.*

Colour. Brown.

Lustre. None.

Transparency. Transmits a little light at the edges.

Fracture. Fine splintery.

Hardness. Gives sparks freely with steel.

By decomposition it takes a cream colour, and an earthy fracture; and, in this state, the diffused particles of quartz are rendered more distinct, from their longer resisting the influence of the weather.

EARTHY FELSPAR.

CONTINUOUS FELSPAR, *Angl. FELSPAR EN MASSE*, Dolomieu.

PETROSILEX, *Journ. de Phys. New Series*, vol i. La Mether.

Theorie de la Terre.

Colour. Brick red.

Lustre. None.

Fracture. Earthy.

Trans-

Transparency. None.

Hardness. Give sparks freely with steel.

Dolomieu, in a paper published in the *Journal de Physique* *, endeavours to prove that this fossil is distinct from felspar, and, after a long chain of observation, he concludes by naming it *Petrofilex*. La Metherie, who seems of the same opinion, denominates the true hornstone of the Germans *Keratite*, and agrees with Dolomieu in applying the term *Petrofilex* to this fossil †. I am, however, still inclined to think, that it will be more correct to use the terms hornstone and *petrofilex* in the signification as adopted by Werner; and that the *petrofilex* of Dolomieu is to be considered as a species of felspar; or, if it be truly distinct from every other fossil, that it should be distinguished by a name that has no reference to one already in use. Dolomieu always refers it to the rocks of primary formation; yet this is not quite correct; for Reufs ‡ mentions a species of porphyry, with a basis of earthy felspar, resting on sandstone.

LIME-

* Vol. i. New Series.

† *Theorie de la Terre*, tom. ii. p. 173.

‡ Reufs, *Aufsatze*, § 388. *Mineralogische von Boehmen*, B. ii. § 124.

LIMESTONE—*between Loch-na-gaul and Loch-Skriddan.*

Colour. Yellowish.

Lustre. None.

Transparency. None.

Fracture. Fine splintery.

Hardness. Scarcely yields to the knife, and sometimes strikes fire with flint.

Contains, sometimes, crystallized rhomboidal calcareous spar; also dispersed particles of quartz; which are frequently so plentifully intermixed, as to increase the hardness very much. But the most remarkable intermixed substance is flint and hornstone.

The flint has the following characters:

Colour. Greyish black.

Lustre. Like that of common flint.

Transparency. Transmits light pretty freely, but objects cannot be discerned.

Fracture.

Fracture. Conchoidal; sometimes multiplied conchoidal.

Hardness. Gives sparks plentifully with steel.

It has immersed in it particles of quartz similar to those we observe in the limestone; and also intermixed is the hornstone, which has the following characters:

Colour. Light blue.

Lustre. None.

Transparency. Allows light to pass at the edges.

Fracture. Nearly even.

Hardness. Gives a few sparks with steel.

It has also, interspersed, calcareous spar and quartz. By action of the weather, it becomes opaque and white; and the quartz and calcareous spar falling out, causes the hornstone to have a cellular appearance. Not unoften we observe the hornstone passing to flint, and *vice versa*.

Dr Walker, in his mineralogical lectures, informs us, that, although he has travelled over a considerable extent of Scotland, he has seldom observed any appearance of flint. This warrants us to conclude that it is a rare production in Scotland.

land. Similar limestone rocks, containing flint, occur in the north of Ireland, in Switzerland ‡, and my friend Mr Deriabın informs me that he observed a rock resembling that of Mull in Transylvania.

GRANITE—*from Rofs, in Mull.*

This granite, which forms the coast of Rofs, in Mull, is composed of beautiful flesh-coloured felspar, white quartz, and black mica. Sometimes the granite is very small-grained, with a great proportion of black mica, which gives it a blackish colour; or we observe it where the felspar is in the greatest proportion, when it has a fine uniform red colour. Rarely we observe whitish-coloured crystals of felspar, and steatites; which last, according to the observations of Werner, is formed by the decomposition of the mica.

G g

BASALT

‡ Helv. Mag. 116.

BASALT—*Torloisk, Luggan-Ulva, &c.*

Colour. Black.

Lustre. Slight degree, from a number of very minute, shining particles.

Fracture. Even, passing to conchoidal.

Hardness. Gives a few sparks with steel.

Streak. Grey.

The weather seems to have very little effect upon it, excepting when it contains iron pyrites. It frequently contains zeolite, which is generally radiated; and is sometimes to be observed passing, by imperceptible gradations, to fine milk-coloured chalcedony. As the late Mr Pelletier of Paris has shown that zeolite contains potash, and as it here passes to chalcedony, it is not improbable that some species of chalcedony may afford alkali.

WACKEN,

WACKEN, highly impregnated with Iron—*Torloisk.*

Colour. Tile or copper red.

Lustre and Transparency. None.

Fracture. Even.

Hardness. Yields with considerable difficulty to the knife.

Is very heavy, and emits an earthy smell when breathed upon. I observed it passing into common wacken.

ON COAL.

CHAP. XV.

Method of discovering Coal.

AFTER the description which I have given of the different appearances of coal in the island of Mull, I intended to have added a short account of the method to be followed in discovering coal strata or veins; but I found that this would be more distinct if detailed in a separate chapter. I shall now, therefore, state the observations.

If a certain extent of country is supposed to contain coal, we should begin our examination by determining the extent of the primary strata; which will considerably abridge our labour, as these strata never contain coal.

We

We should next examine the nature, direction, dip, and relative extent of the different secondary strata; which will give us an opportunity of discovering any appearances that indicate the presence of coal. These particular places are to be examined with the most scrupulous accuracy; and the coal strata to be sought for by digging, or boring, according to the nature of circumstances.

Such is the general mode of proceeding in these researches. I shall now mention, particularly, the rocks which are indicative of coal; then the method of determining whether coal strata do exist in a certain situation—first, as determined by the appearance of fragments of coal, and, secondly, by boring, where no actual appearance of coal is discovered.

The principal rocks, which are mentioned by mineralogists as indicative of coal, are the following:

1. White argillaceous sandstone. If this sandstone has, interspersed, bituminous or carbonaceous matter, it is reckoned a good symptom of the vicinity of coal.

2. If

2. If bituminous shale, shistose clay and argillaceous ironstone are observed, it is a further, and a very favourable symptom of coal.

3. If sandstone and limestone alternate, and be accompanied with bituminous shale, it is reckoned favourable for coal.

4. Sometimes where sandstone and basalt alternate, coal has been found.

5. Mr Kirwan remarks that there is great probability of finding coal in the neighbourhood of mountains of argillaceous porphyry †.

6. Although coal has never been observed alternating with primary strata, yet it has sometimes been found in their immediate vicinity; and coal has even been observed lying on granite. I believe, however, that such coal strata are generally trifling.

Having

† Geological Essays, p. 347.

Having, from an accurate investigation, discovered such strata as render the presence of coal probable; we must next endeavour to discover its actual existence. To do this, we must examine the beds and banks of rivulets, where, if small pieces of coal appear, we may be pretty certain that coal strata exist near at hand. Ditches are to be examined; for, in forming them, it is often necessary to cut thro' the thin covering of gravel and sand which conceals the crop from our view. We sometimes observe a footy-like matter spread on the ground: this is formed from the decomposition of coal, and is therefore a good symptom of its vicinity. Not unfrequently we observe masses of coal, or bituminous wood, immerfed in the breccia which is observed in coal countries: but this is often a fallacious appearance; for, upon cutting thro' the breccia, we find that the subjacent rocks contain no coal; so that the pieces of coal or wood, which the breccia contains, are to be considered as merely accidental.

After having observed any of the above-mentioned appearances; our next endeavour is to observe the crop, or the outburst, of the strata. This is a matter of much difficulty; and requires particular attention to the disposition of the fragments of coal, &c. If they be found upon the banks or bed of a rivulet,

vulet, we must search from one extremity of the ravine to the other, to discover the crop of the stratum. If the foot-like matter is observed, it will be necessary to remark whether it lies upon a declivity or a plain; as inattention to these circumstances has often been the cause of great disappointment and expence to the coal-miner in overshooting the stratum, that is, cutting beyond its real situation. Upon a declivity, we know that the decomposing and loose matter of a crop will naturally spread downwards, in proportion to the steepness of the ground. On this account, wherever appearances of coal occur upon a declivity, we must trace the debris upwards; when we shall find it increase in depth towards the crop, and the coal is less and less decomposed as we approach nearer to it. On the other hand, where the footy matter occurs upon a plain, we always find it thicker, and far less spread, than upon a declivity; and, what is of consequence, it often spreads in a direction contrary to the rise of the strata. If we are so lucky as to observe the crop, we now endeavour to detect the stratum; which we do, either by digging towards its dip, or by following the fragments of coal until we have the stratum fairly under our eye.

It often happens, however, that a country may be, in general, very favourable for coal, yet no pieces of coal or footy matter are to be observed, owing to the coal strata lying deep: in such cases a good deal of discernment is necessary to determine the particular places where the trials are to be made. As it would be very expensive, in such cases, to dig down until we should meet with the coal, the common practice is to bore the ground; by which, at a small expence, we can know the magnitude and nature of the strata, to a great depth.

In searching for coal, by boring, our first object is, to determine the point to which the strata rise; as it is this which enables us to determine at what place we shall begin to bore. The plan, at the end of this chapter, will sufficiently explain the mode of proceeding in this operation. Suppose A B C D to represent a tract of country which is suspected to contain coal, and where the rise of the strata is towards A. We there make the first perforation, which will pass thro' the strata 4, 3, 2, 1, to the depth of ten or twelve fathoms. If no coal occurs among these strata, it is better to make a new perforation, than to sink deeper. We therefore proceed onwards to B, where we suspect that the stratum 5 is ten or twelve fathoms deep. We here bore through the strata, 8, 7, 6, to 5;

H h

and,

and, as no coal occurs, we do not bore deeper, but proceed to the point C, where we make a perforation through the strata 11, 10, 9, to 8. By being still unsuccessful, we proceed onwards to D, where the stratum 11 will be about ten or twelve fathoms deep, and here we find coal at 12.—By this practice, it is plain that that no stratum of coal can escape notice, as the last perforation always reaches down to the stratum which was nearest to the surface in the former bore.

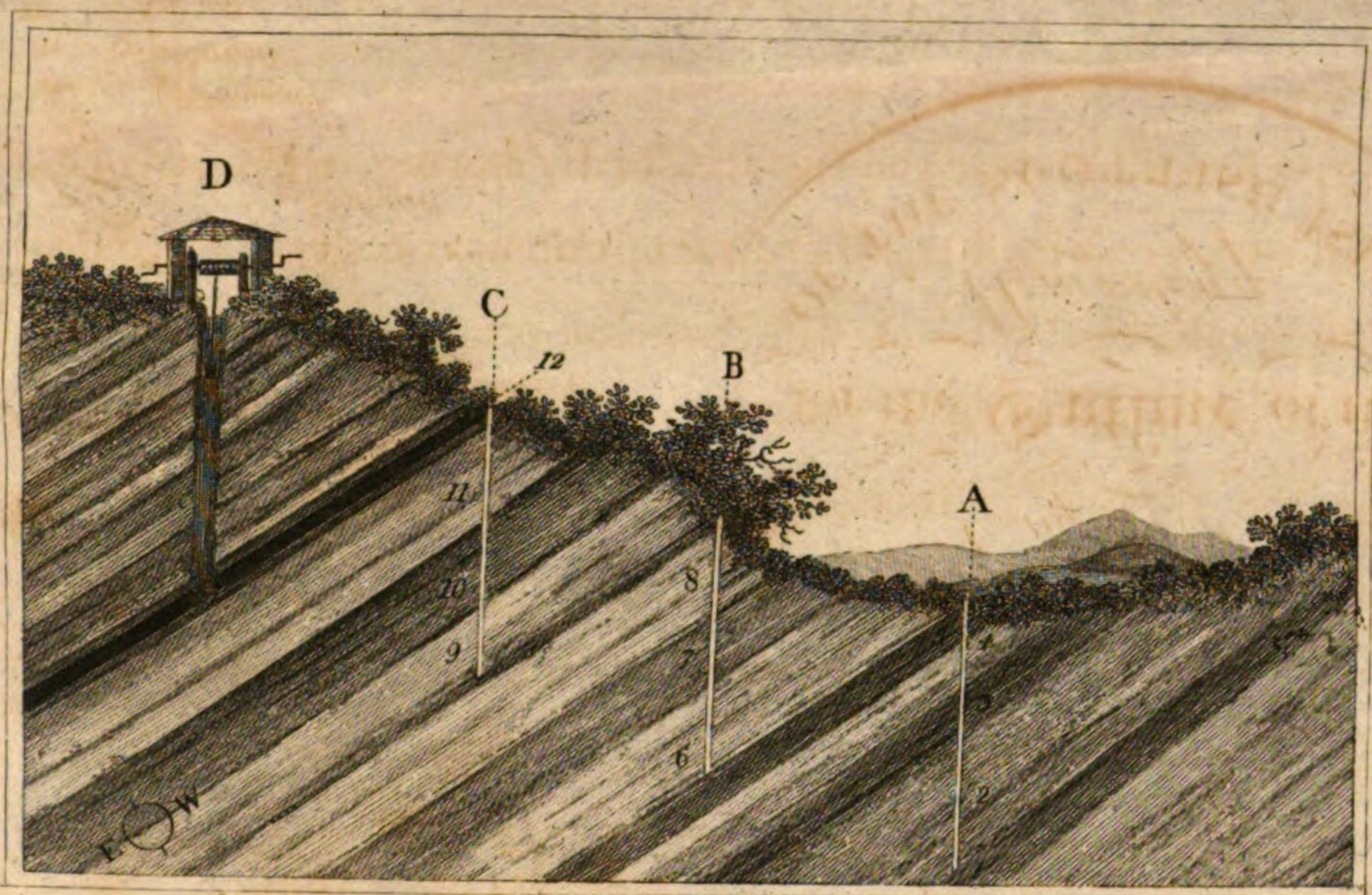
Having discovered the breadth of the stratum, either by digging, when it is near the surface, or by boring, when it is covered by a great load of other strata; our next concern is, to determine whether it be of sufficient importance to be worked. If it is not more than 15 inches in breadth, even altho' pretty near the surface, it is not worth working; but if it be two feet, or two feet and a half wide, and of good quality, it can be worked in most situations with advantage.

The quality of the coal is ascertained from the following circumstances:

1. Its general appearance: whether it be more or less mixed with stoney matter; or if there be laminæ of bituminous shale
- or

or sandstone, dividing it into stratulæ; or if it contains much pyrites or fulphuret of iron.

2. To these may be added the test of chemical analysis, by which we ascertain the proportion of carbon, bitumena and ashes.



Plan illustrating the method of boring for Coal.

END OF VOLUME FIRST.

of sandstone, dividing it into strata, or if it contains much pyrites or sulphuret of iron.

3. To these may be added the test of chemical analysis, by which we ascertain the proportion of carbon, hydrogen, and other elements.

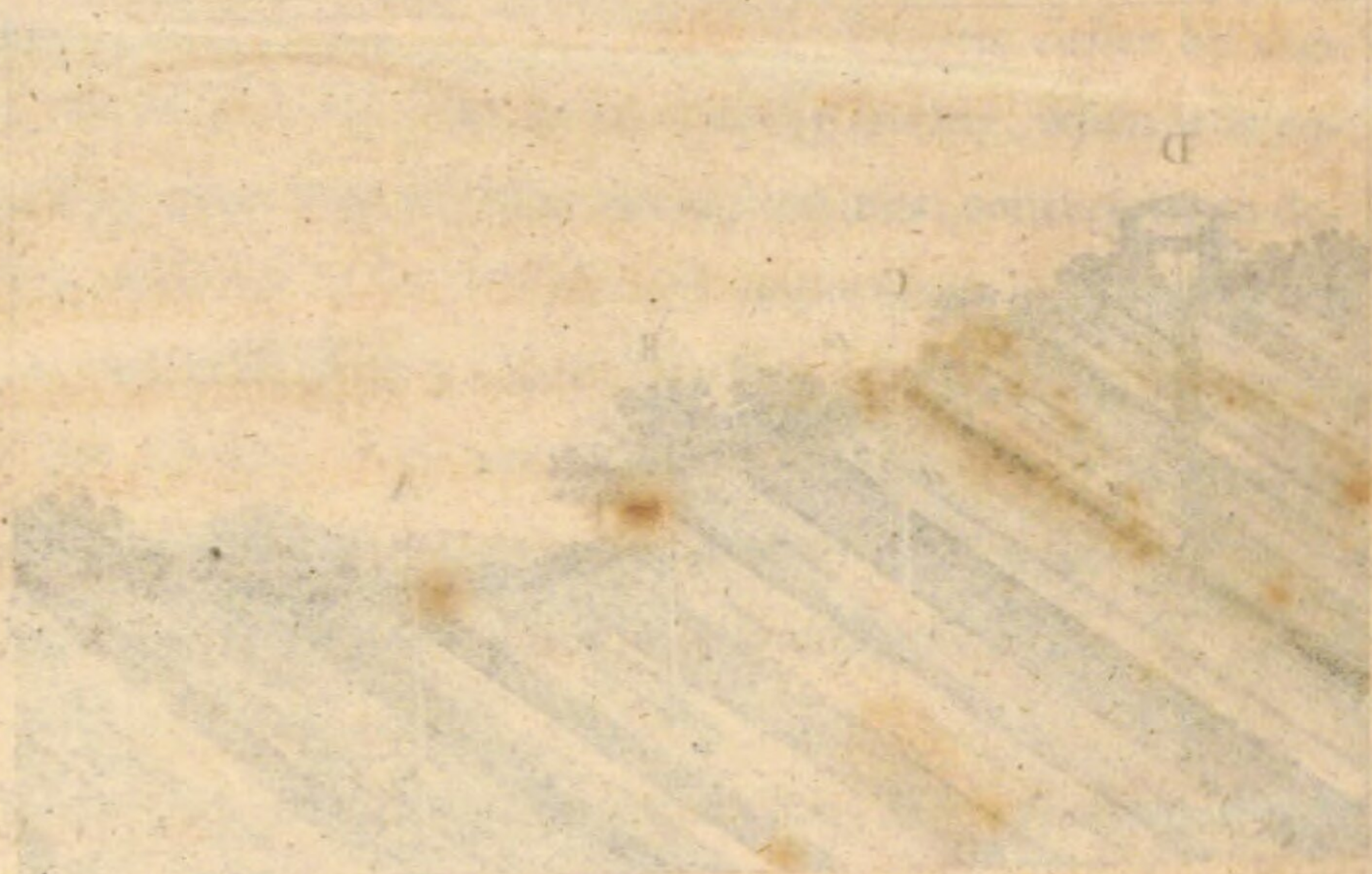
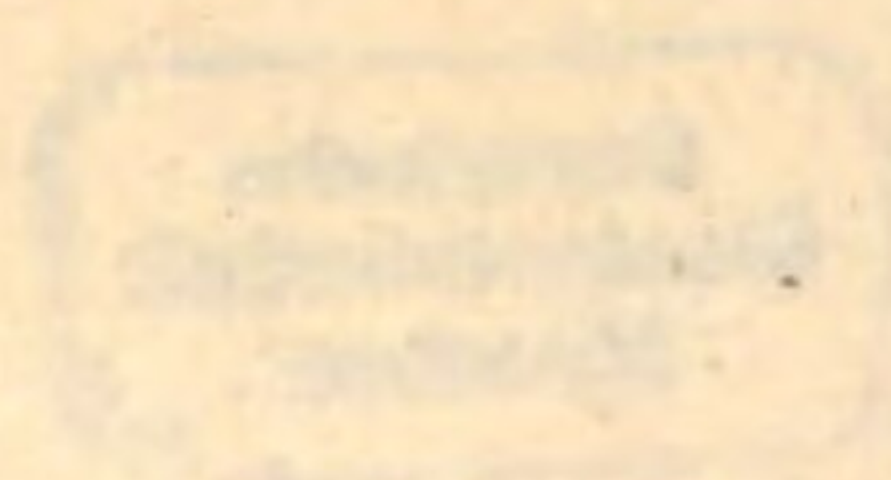


Diagram illustrating the method of separating the different strata of a coal seam.

END OF VOLUME FIRST



Jameson, Robert

Mineralogy Of The Scottish Isles With Mineralogical Observations Made In A
Tour Through Different Parts Of The Mainland Of Scotland, And
Dissertations Upon Pear And Kelp : In Two Volumes : Illustrated With Maps
and Plates
Bd.: Vol. I.

Edinburgh 1800

4 Lith. 84 m-1

urn:nbn:de:bvb:12-bsb10226099-4